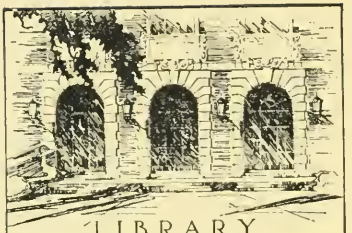

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THE VERTEBRATE FAUNA OF CHESHIRE AND LIVERPOOL BAY

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THE DEE MARSHES.

[*Frontispiece*]*

THE VERTEBRATE FAUNA OF CHESHIRE AND LIVERPOOL BAY

EDITED BY

T. A. COWARD, F.Z.S.

AUTHOR OF "PICTURESQUE CHESHIRE."

IN TWO VOLUMES

VOLUME II.

THE DEE AS A WILDFOWL RESORT

BY

JOHN A. DOCKRAY

THE REPTILES AND AMPHIBIANS OF CHESHIRE

BY

T. A. COWARD AND C. OLDHAM, F.Z.S., M.B.O.U.

Authors of "The Birds of Cheshire"

THE FISHES OF CHESHIRE AND LIVERPOOL BAY

BY

JAMES JOHNSTONE, B.Sc. (Lond.)

Author of "British Fisheries" and "Conditions of Life in the Sea"

WITH ILLUSTRATIONS FROM PHOTOGRAPHS BY

THOMAS BADDELEY

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THE DEE AS A WILDFOWL RESORT.

By John A. Dockray.

To anyone standing on the picturesque sandstone bluff of Burton Point at low water on a clear day, a magnificent view, almost unique of its kind, is presented. For over twelve miles the estuary stretches away to the north; immediately opposite him, where stands the busy little port of Connah's Quay, it is two and a quarter miles in width, but at its mouth, down by the island of Hilbre, it has widened out to some six miles from shore to shore. Hilbre is faintly discerned on the east side in the haze of distance, raised, may be, by the mirage till it appears floating high above the horizon; on the west, the low sandhills and disused lighthouse of the Point of Air stand out plainly beyond the smoke of Mostyn's furnaces. Immediately at his feet, extending for some three miles or so, is the dead level of Burton Marsh, clothed in the brightest of green grass, on which countless sheep are feeding; beyond, the dull grey-brown of what is neither mud nor sand—an oozy mixture, rapidly growing up into marsh—and then the golden sands, mile upon mile, like some gorgeous carpet of all shades of colour. The main channels of the river—thin blue stripes winding aimlessly—are now hidden by the varying levels of the sandbanks, now visible for a mile or so, then vanish once more. The Welsh side rises rapidly in beautiful slopes as if gently forbidding the eye to wander from the estuary.

As his gaze slowly travels from the south towards the north, the beholder sees the embankment of the Burton Cop in front of him, reaching across to the main channel of the river opposite Connah's Quay, with its two huge

gaps—a quarter of a mile wide—carved out of it by the tides soon after its completion and never repaired. From the end of the Cop a training-wall, some three miles in length, extends nearly to Flint, and keeps the main channel within reasonable bounds; beyond again, the river takes two main and ever altering courses across the Sands o' Dee, one hugging the west side past Flint, Bagillt, Greenfield, Llanerch-y-mor and Mostyn to the Point of Air, the other trending north-east towards Parkgate and Heswall, by Dawpool and Caldy, to Hilbre, and so to the Hoyle Banks of Liverpool Bay. But the observer on the Point is hardly conscious that these channels exist at low water; they can only be detected here and there amongst the banks; they are insignificant, of no width or depth, and did he but know the right places he would have no difficulty in wading across from Cheshire into Wales.

While he has been drinking in the beauties of the scene, a change has come over it. The broken strips of blue water in the channel are joining up, and away to the north-west he sees the sails of the Parkgate shrimp trawlers slowly advancing. Perhaps, opposite Flint, he is aware of a line of white, of breaking water; it is the flood tide, the line of white its head, the "bore," rushing up at seven or eight miles an hour, forming a solid wall of water two to four feet high as the channel narrows. Gradually to his eye, but really very quickly, the channels fill and overflow, the water creeping up and spreading over the banks and lapping the edge of the marsh. The sheep have been driven off by energetic dogs and are safely penned on shore, the interminable gutters which intersect the marsh in all directions become visible as they fill, and by the time the Parkgate boats are riding at their moorings the whole expanse is covered, for with a twenty-one-foot tide at flood the water laps the foot of Burton Point itself; one gazes on some fifty square miles of sea which but a short time before appeared as all bare land. In the Main, now a noble river, he sees tugs swiftly piloting strings of flats and schooners,

bound for the chemical works at Flint, the wharves at Connah's Quay, and the huge ironworks at Shotton; some are flying the flag that denotes that they are bound still higher up the river, for Sandycroft, Queen's Ferry or Chester, and will require the swing-bridge of the Great Central Railway to open for their passage. As he turns to the south and follows them with his eyes, he sees no longer water, but mile after mile of dead level, green fields, yellow corn or shining root-crops; the water, indeed, flows through the broken Burton Cop and covers a portion of the marsh to the south, but it is hemmed in by the embankment of the Great Central Railway to the east, on the west by the cop of the "Navigation" and to the south by the Shotton ironworks—a few poor square miles of marsh and sand, a mere unnoticeable atom of the huge tract of level cultivation which stretches right away to Saltney and Chester, beyond Shotwick, Saughall and Blacon on the east and Hawarden on the west, an area eight miles or more in length and three to four in width. Such a passing glance at the estuary of the Dee may convey some idea of its appearance at the present time.

It may perhaps be of interest to give a short historical account of the various works undertaken to reclaim and harness the estuary, for such reclamation has the utmost bearing on the district as a resort of wildfowl. In the Grosvenor Museum, Chester, is a series of maps, presented with a report, in the year 1849, on the then proposed improvement of the navigation of the Dee from Chester downwards. The first map, dated 1684, depicts the river pretty much as we find it forty-nine years later, for down to 1732 the main channel was entirely on the Cheshire side from Chester and Saltney, past Blacon, Shotwick and Burton Point to Parkgate. In 1732 there was a depth of fifteen feet at low water and thirty-nine at high water in the channel opposite Gayton Hall, two miles below Parkgate, while Parkgate itself had a fairly deep channel at low water up to 1790 or 1800. Twenty years ago I talked to an old

fisherman in Parkgate who could remember small coasting vessels loading coal at Denna Colliery, and lying at anchor at low water off Parkgate. At these places now there is no water at all at low tide, and it takes a fairly high spring tide entirely to cover the banks. In 1732 a decoy existed not far from Saltney, just to the south of a portion of marsh-land reclaimed by Sir John Glynne, which was probably the earliest bit of reclamation accomplished in the estuary. The Saltney marshes extended so far as Wepre Gutter on the west side, while along the Cheshire side there was practically no marsh, the channel being under the high bank which can still be traced most of the way from Blacon to Burton Point. The rest of the estuary was in all probability huge tracts of sand and slob, even up to Chester and Saltney. A beacon stood on the shore about a mile out from Flint Castle, and no doubt acted as a mark to people crossing the sands at low water on foot, in carts, or on horse-back.

In 1732 an Act of Parliament—the second passed, but the first made use of—gave the right of reclamation from Chester to the sea to one Nathaniel Kinderley, his heirs and assigns. He seems to have set to work at once, for by 1737 we find that the New Cut from Chester to Connah's Quay had been completed, and the navigation of the river diverted from the Cheshire to the Welsh side, as it exists today. By this undertaking the greater portion of the estuary from Chester as far as Shotwick was, at any rate partially, reclaimed, and became very shortly saltings, for in the map of 1771 the marsh-lands to the east of the New Cut, or Navigation, extend to about half a mile south of Shotwick on the east bank and across to the New Cut about opposite Connah's Quay on the west. The New Cut also reclaimed a huge tract of land on the Welsh side between Chester and Wepre.

By about 1790 the Cop, running from near Shotwick Church to the bank of the Cut near the present Great Central Railway bridge, was completed, effectually reclaiming the

whole of the estuary to the south. This large tract of land, some of the finest in the kingdom, was and is still known as Sealand. About 1860 the last attempt at reclamation was made by running an embankment from Burton Point to the stone embankment which marks the end of the New Cut opposite Connah's Quay. This was only partially successful; breaches were made in it in two places soon after completion, and these, patched from time to time to prevent their extension, but never mended, remain until the present time. Enough embankment, however, remained to check the tide and to cause the formation of marshes, and when, about 1898, the embankment of the Great Central Railway was thrown across the saltings, another large corn-growing tract was added to Sealand and the tide for ever kept back. Within the last fifteen years or thereabouts, a training-wall has been extended along the east side of the main channel from Connah's Quay to a little south of Flint, which to a great extent has restricted the duration and flow of the tide towards the Burton Cop, and assisted the formation of saltings on the north side of the Cop and the extension to the north and west of the Burton marshes.

What must this estuary have been like a hundred years ago? Can we picture it before railways existed on either side, before any serious reclamation had taken place, when there were no puffing, snorting tugs, with their shrill whistles, in the tideway, no clanging steam-hammers or shrieking "devils" at the unbuilt works, few sheep even on the marshes—nothing in short to disturb the solitude of those endless miles of flat, flat marsh and sandbank? The whole of that vast area was one trackless waste of marsh, mud and sandbank, and the tide still flowed up the old channel on the Cheshire side, though the navigation had been diverted in 1737; little by little, from 1730 to 1860, the land was reclaimed and the river confined more and more to the Welsh side. A hundred years ago there was a deep low-water channel at Parkgate—the port of departure

for Ireland. That there must, on the Welsh side, have been fairly good channels is evinced by the disused wharves at Pentre and Flint for shipping chemicals and at Bagillt and Greenfield for coal; only at high water of spring tides is there any depth at these places now. The estuary is silting-up, and it takes a twenty-one-foot tide to cover what an eighteen-foot tide flooded twenty-five years ago. Perhaps the land has not risen so many feet, but so great have been the alterations and the consequent accumulation on the banks, that the water has not time to cover all between flood and ebb. What a paradise for birds must these miles of saltings and flats have been! The wildfowler, as he gazes on the present and considers the past, may call it Ichabod, not Sealand, for in truth its glory has departed. Gone are the thousands of Barnacles, once the geese of the river, the countless companies of Wigeon and other ducks, the hosts of waders; compared with these armies a mere handful remains today. Even in the writer's recollection, which extends back for but a quarter of a century, the numbers of fowl have sensibly diminished; twenty-five years ago there was no railway embankment, no works at Shotton, no training-wall to Flint. The big tides flowed right up to Shotwick, where I have been in the punt and shot duck where now corn is grown. In those days, with a big tide and northerly wind, good shooting was possible from the Burton Cop; lot after lot of Mallard, Wigeon and Pintail would pass up within shot as the tide flowed, and return with the ebb. In autumn days the Golden Plover came off the fields above Shotwick to the saltings exposed by the ebbing tide, and many a good day's sport did we have shooting from some gutter or hole in the marsh. All is altered now; since the construction of railway and ironworks the birds have to a great extent shunned this portion of the estuary—and small wonder. Only a few years back I was told that fifty gun licences were taken out annually by the hands at the ironworks alone, and a large contingent from Neston and Parkgate shoot the marsh; the birds are

harried and allowed no peace, and now it is exceptional to see any number of fowl about the marsh or high up the river ; only with a whole gale and big tide do they venture up. One cannot but admire the true sporting instinct that takes these shooters out in all weathers, day or night, in the hope of securing a duck or two, for most days must be blanks ; though to give the men credit, they try what their guns will do at impossible ranges !

Twenty years ago it was worth the five or six miles tramp from Parkgate to the Cop to shoot the morning flight if the wind was favourable ; many a time in the black darkness of a chilly winter's morn we have set off, lantern in hand, to be there by daybreak. Then the ducks, chiefly Mallard, with Wigeon, Pintail and Sheld Duck, would come streaming down in long strings—a beautiful and exciting sight—against the first glimmer of dawn. If struck when flying high they would carry on a long way ; many times we have picked up dead birds five or six hundred yards behind our stand. Thirty-five ducks of various kinds in five consecutive mornings' shooting was the best bag of one keen and indefatigable sportsman. With a suitable wind, light and sky, the evening flight was also good ; at times I have heard the guns on Burton Marsh like a mimic battle, but on so wide an expanse it is difficult to hit the lucky place—in the line of flight—and this knowledge was only acquired by very close observation of wind, tide and time, and at the cost of many disappointments. We used to entrench ourselves on the bare sands near to some gutter, one of which earned the name, which still clings, of the "flighting gutter." It was a wet and chilly performance, for the banks are water-logged a foot or so beneath the surface, but unless one made a proper entrenchment, smoothing the sand dug out into a long flat slope to resemble the dip of the bank, the chance of birds passing within shot was slender ; if one stood on the bare sands, or even crouched, the keen eyes of the birds detected the presence of an enemy. Flighting though still followed by a few is almost a thing

of the past, and except perhaps on the private reclaimed land is hardly worth the labour. In exceptionally severe weather a few birds are obtained, but now there is not one duck to fifty which came twenty years ago.

There was, in the old days, what may be called a much larger permanent winter stock of wildfowl. In hard weather, with continued frost inland, this stock was constantly reinforced by birds from the meres, lakes and ponds ; the sights then were exhilarating beyond words ; only in very hard weather nowadays do the numbers become great. The winter of 1906–07 was severe inland, and the meres of Cheshire and lakes of Wales were frozen for weeks, consequently we had a considerable show of home-bred and inland-frequenting birds in the estuary to augment the normal winter residents, but even then there were nothing like the numbers which appeared in 1889, 1890–91, 1892, and especially in 1894–95, when we had the only real hard frost of recent years.

The first man to follow the pursuit of wildfowling in the Dee in systematic manner with punt and gun was William Kemp, known locally as "Billy th' Duck," who came from the Fen district of the east of England about 1800, and who amassed a considerable fortune from the sale of wildfowl in winter and the capture of Salmon in the summer months, combining these pursuits with sheep-farming. Billy was a dapper little chap, up to all the dodges, and full of knowledge of the birds he pursued. With his punt and big gun he must have had rare sport and profit, for he had an open field and no rivals. In those days, and down to about 1860, the Barnacle Goose frequented the river in thousands. A very entertaining description of the sport of shooting the Dee Barnacles, with an account of "Billy th' Duck," is to be found in Birch Reynardson's *Sports and Anecdotes of Bygone Days*.

William's son, James Kemp, told me a year before his death, which occurred in May, 1905, that these "Brent Geese," as he persisted in calling them, continued to frequent

THE LATE JAMES KEMP, A DEE WILDFOWLER. [xxviii]*

the river until about forty years previously. Why they should have left and been replaced by Pink-footed Geese, which now come annually, no one can really tell; it may be a question of food, for the Barnacle and Brent are more marine feeders than the Grey Geese, and perhaps in early days there was plenty of the sea-grass, *Zostera marina*, these birds delight in, which has been replaced by marsh herbage. Whatever the cause, the Barnacle has gone; during my experience of the estuary, dating from 1884, I have only met with it twice. I had further corroboration that the so-called "Brent" was the Barnacle from one Beatty, an old man who still lives at Neston. He told me about the construction of the Burton Cop, on which he worked, and related how he had once in very hard weather shot ten or twelve "Brent Geese" with a shoulder-gun on the marshes. He described the bird as black and white, and I took him indoors and showed him a case containing both a Brent and a Barnacle; he at once pointed to the latter as being a "Brent," similar to the birds he had shot, and said he had never seen the other—the true Brent—in the river. This confusion of species is not confined to the Dee, for the name "*Anser bernicla*" was applied by some old writers to both species. "Auceps," in an article on "Shooting on the Hampshire Coast," in the *Gentleman's Magazine* for 1857, speaks of the "Brent Goose or Bernacle proceeding in prodigious numbers over the aqueous waste."

"Billy th' Duck's" two sons, James and Ned, both fine big men well over six feet in height, followed their father in the pursuit of fowl with punt and gun, combining profitable sport with their calling as sheep-farmers. Of late years, owing to the alterations in the channels, they did little, for they were too far up the river—too much on the marsh. James Kemp, who was full of stories of the wildfowl in the river thirty to fifty years ago, often bewailed the absence of sport in these degenerate days. His outfit was not suitable for far afloat, his punt being quite small and but slightly decked; he could only with safety creep about

the shallows and gutters near the edge of the marsh and Cop. His old muzzle-loader must have slain a wonderful number of birds in its time. I often used to see him when we were serving our apprenticeship to the noble sport twenty-five years ago; he used to keep his punt in what he called the "Pough Hollow," a gutter running up the marsh from the deep near Flint. As we came up on the flood from Parkgate, we would see the old man in front of us, and that meant that he had first innings at any "stuff" that was about. We had some strange ideas about the sport in those days; one, I remember, was that white was the best colour for the fowler's costume, but James wore an old ragged black overcoat and a black felt pot-hat—a most conspicuous object one would think—and in spite of this garb approached fowl so quietly, without movement of head or body, that he generally pulled off his shot. He told me that the rarest bird he ever shot was a Spoonbill, and that he once killed a white Wigeon. He pointed out a spot, then all grass, close to the sheep-pen above Denhall, where in former days there was a big gutter, associated in his mind with a famous shot at Barnacles, when he secured thirty-three. He was a most interesting man to talk to of bygone days, though he would usually end with a wail over the present conditions, for he said the fowl, disturbed by so many shooters and other disquieting causes, had given up coming to the river, where "they get no harbouration nowadays."

Another fowler of the past was old Lawton, a carpenter by trade, who lived for many years in a delightful one-storied house of his own building on the site of the old quay near Denna Colliery. Many a time have I called in for a cup of tea and chat in the old ship's-cabin of a house, which was crammed with stuffed birds and all manner of curiosities from over-seas; he was an intelligent and racy conversationalist; it was a treat to listen to him. The house of this keen wildfowler was well placed, his punt always handy in a big gutter at his very door. This gutter led right

into the heart of the marsh ; on the west side of it was the portion he appropriately called "The Knobs," consisting of masses of marsh in the process of formation and ever gaining on the sands to the west and north—a favourite place for Wigeon to feed. Like Kemp's, his punt was small and only half-decked, unsuitable for deep water. His gun was a curiosity ; the barrel was a portion of a Chinese jingal, with bell-shaped muzzle, brought from Shanghai, the lock taken from a Russian musket from Sevastopol, and the whole bound by wire to a stock of his own manufacture. He used a solid piece of blasting-powder, three ounces in weight and some four inches in length, as a charge for this extraordinary weapon. Of course he made his own punts, and he built two for Brooke, in which we learnt the first rudiments of wildfowling afloat, and in which we mounted an old muzzle-loader, about an inch and an eighth in bore and seven feet in the barrel. The recoil of this gun was taken by a rope hitched round the nose of the punt and fastened through a loop on the underside of the barrel ; sometimes when fired the whole affair went by the board. Nevertheless, we killed a good many fowl with it, Brooke once accounted for eight geese at a shot. Lawton, who in his time had killed many wildfowl, had stories of the greater abundance of birds in the estuary in early days ; once he got twenty-three Wigeon off the Knobs at a single shot with his old gun. I well remember calling at his house one day on my return from the marsh ; I was covered with mud after a long crawl that had resulted in two Grey Plovers, new birds to me then. Lawton knew them—"Silver Plovers" he called them—and at once spoke of their former abundance. He had killed over one hundred and twenty at a shot. The bird is rare now ; a few pass along the estuary on the autumn migration, and on big tides, up to about November, may be seen flying at the edge of the marsh, but after November it is seldom met with. Lawton joined the great majority about ten years ago, and there is now none of the old fowlers left.

From the foregoing remarks the reader might think there were no wildfowl at all in these degenerate days, but this is not the case; from the wildfowler's point of view there are still a good many birds of all kinds. Given a hard and continuous frost, such as we had in 1894–95, a frost that lasted without a break for nearly three months, and during which on several occasions early in 1895 the thermometer stood below zero, you will see the fowl assemble in fair numbers once more. Unfortunately, after about three weeks of this hard weather it was dangerous, and at times almost impossible, to follow fowl in the punt; one ran a serious risk, or even a certainty, of being either smashed up or sunk by the ice that came grinding and crashing up on the flood. The estuary during that frost presented a remarkable appearance; the whole of the southern portion, say south of a line drawn from Parkgate to Flint, was practically a mass of ice some four feet in thickness, broken up into all kinds of shapes and sizes, some pieces standing upright, others inclined at every conceivable angle. The gutters were obliterated, full up with ice, and the water simply ran wherever it could. In places huge masses—icebergs—dotted the banks, some so large and heavy that no tide ever floated them, but most of this great mass, several square miles in area, was shifted slightly up and down on every tide. Huge tracts, acres in extent, would be carried down perhaps to the mouth of the river on the ebb, only to return on the next flood; the gutters were a solid moving field of ice streaming out to sea. As the tide dropped, pieces would be left stranded on the banks, until at low water the gutters below Flint and Parkgate would be clear in the centre though lined with ice along their margins. A fowling-punt would stand little chance if launched amongst this moving ice, for many of the pieces were tons in weight and drove along at four to six miles an hour on the tide; if once the punt got fast the gunner would be helpless. Once or twice I was caught in it and with difficulty escaped from its clutches, and Brooke

SETTING TO FOWL ON THE EDGE OF THE MARSH.

was once caught with an offshore wind and ebbing tide and carried out in the embrace of an immense floe. After a long fruitless battle he, as a last resource, got the anchor down, and then, sitting with the man at the gun-end, raised the stern sufficiently to prevent any ice overrunning them; so they rode until the tide dropped and they could pole out. Had the anchor dragged or the rope been cut, nothing could have prevented them from being swept out with the ice to the mouth of the river or maybe beyond; it is impossible to row when surrounded with ice, and in deep water one cannot pole; once in the grip of a big floe one is helpless.

I had one sufficiently exciting adventure—a warning of what might easily befall a rash punter; I was lucky to get out of it as I did. On the last of the ebb, on December 28th, 1892, we set off down Denna Gutter from Moorside, above Parkgate, where the ice had been left stranded on the banks. We went down without difficulty to the place where the gutter joined the main deep, in those days just opposite Gayton Cottage. It was a grand day—bright sun, dead calm and intense frost. The water froze at once upon the oars and deck of the punt, and every now and then it was necessary to break it off, for I found myself rowing with a huge bludgeon, mostly ice. The main deep reached, we landed to reconnoitre, and saw that it would be madness to go on or attempt to cross, for the whole deep was full of immense slabs of ice coming down on the ebb, some of them being half an acre in extent and very thick. The tide here was running out at six or seven miles an hour, and every now and then a big floe near the shore would come ploughing along, cutting a great furrow in the sand as it spun round and round and ground along the edge of the main. It was an object lesson of the power and weight to be battled with had we ventured out. Upon many of these floes were fine lots of ducks, mostly Mallard; they were fast asleep, some crouched, some on one leg, with their bills tucked away in the feathers of their backs. Many

from which the ice was broken off and on the part of the bank above the previous high-water mark. So the process goes on with each ebb and flood, and as the tides spring higher the currents run faster, and the ice is broken up and whirled in all directions. Pieces and floes are piled on the top of one another and freeze together, forming big masses—the bergs of the estuary. In 1895 some of these were twelve feet high, or more, and fifty to sixty feet in length, tremendous masses many tons in weight. If calm weather prevails, the ice tends to pack to the height of the highest tides, where it is left on the ebb, and the accumulation grows less and less as the tides neap again. A fall of snow on the banks often causes icebergs; the frozen snow lifts on the tide and freezes together in layers. The appearance of the estuary in 1895 was very lovely so long as the ice and snow were clean, the whole flashing with prismatic hues in the brilliant sunshine; but when the big tides had covered the ice many times the whole became muddy and soiled, and on a dull day the prospect was dreary indeed. Should a strong wind prevail from the south, the ice is mostly carried out to sea and broken up. During prolonged frosts the ducks lose condition in a few weeks; they are not worth shooting, and, indeed, are too easy to get; one has only to sit near a spot where there is a dribble of fresh water to get two or three at any time during the night or even day.

The Dee is a very exposed estuary for punting, and the tides are strong and often dangerous; it is only safe for the sportsman who has an intimate knowledge of the ever shifting banks and gutters. Looking through our carefully kept records, I find that it is generally too windy to venture afloat two out of every three days throughout the season, and that the really calm and delightful days are few and far between. There is, indeed, generally a breeze in the estuary, which spoils the day for punting. A double-handed punt is undoubtedly most suitable for such waters as those of the Dee Estuary, though a very heavy gun is not necessary,

"ICEBERG" IN THE DEE ESTUARY, 1895.

for the chances of a really big shot are remote. A gun throwing from sixteen to twenty ounces of shot is quite sufficient for anything likely to be met with.

As details of the occurrence of the more interesting birds are given elsewhere, there is no need for me to do more than give a short account of the fowl met with during over twenty years experience of the river.

Wild Swans are frequently seen, a winter rarely passing without a few visiting us, and not infrequently Mute Swans, generally two or three together, come to the river from inland resorts. We have shot most of the species of geese that visit the county. Barnacles have now deserted the Dee, as previously mentioned, but Brent are not uncommon. The Grey Lag we have once obtained, and the Bean is rare, but White-fronted Geese are fairly regular in their visits. We have each failed to pull off a big shot at the last named; Brooke once had a grand chance at about twenty, but when waiting to take them in the air, found that the gun was too heavily balanced forward and shot under them; I had a chance at fourteen on "Big Ben"—the bank opposite Flint—which is very steep. The birds appeared to be sitting on the edge of the ridge, but were really some yards on the far side of it, where the bank sloped away from the river. Creeping in too near to the bank I lost sight of my birds and had to shout them up and take them flying; I only accounted for three.

The Pink-footed is now *the* goose of the river; it has increased in numbers within the last few years, and now from eight hundred to a thousand birds come every season. So far as I can see, the birds have no settled time for feeding; they go inland both by day and night, and frequent the Sealand fields; when in the river they usually gather on some inaccessible bank, safely guarded by their sentries. They are wary fowl, and a successful shot at them with the big gun is most difficult to obtain; nineteen and twenty-one at a shot are Brooke's best, and I got sixteen early in 1908, but, speaking generally, it is labour lost to follow them.

I know no more beautiful sight than to see the whole army of geese resting on a dry bank in bright sunshine, most of them fast asleep, but a few preening their feathers, the sentries only standing. When the punt is some distance away the birds appear to pay no attention to it, but it seldom approaches them within four or five hundred yards without one of the standing birds raising a warning "honk, honk." Immediately all heads go up, the birds begin to "talk," and then, with a noise like thunder, all of them rise and are off, only settling again when several miles lie between them and the punt.

The most abundant duck in the estuary is the Mallard; all through the season there are some in the river. Perhaps the majority of the earlier arrivals—those which come between August and November—are home-bred or immigrants from the near countries of the Continent, for they are larger and more heavily built than those that come later, possibly from more distant lands. As a rule, the Mallards consort with Wigeon and Sheld Ducks, but at times several hundred Mallards may be seen together in one lot.

The beautiful little Teal comes in fair numbers at times, generally in September and October, for the bird, both here and in the Mersey, is more of a bird of passage than a winter resident. The Pintail, handsomest and most aristocratic of the river ducks, is one of the wariest; its numbers in the river appear to be decreasing; in former years Brooke has seen so many as two or three hundred in one lot, but now we seldom get them apart from flocks of Mallard. The young Wigeon usually reach us early in the autumn, and, so far as one can tell, pass on; the older birds, which stay the winter, come later. There is often an interval, about the beginning of November, when there are no Wigeon about—the young have passed and the winter residents not arrived. In the Dee, though their numbers vary considerably in different years, we never see them in the huge quantities which may be noticed in places where their

favourite *Zostera* grows ; in Anglesey and on the Irish coast, for instance, I have seen companies several thousand strong, but in the Dee this, the best sporting duck of the puntsman, is never very abundant.

What shall I say—what have I not said—of the handsome Sheld Duck, spoiler of nearly every good chance of a really big shot ? Ever on the alert, it gives warning to the sleeping Mallard and Wigeon, and though rarely shot, remains wildest of all the ducks, and is even more wary than the Curlew. The Shoveler and two of the diving ducks—the Pochard and Tufted Duck—though they occur occasionally, are not regular salt-water fowl, and the Golden-eye, though not uncommon, is never numerous ; the Scaup, on the other hand, is a marine duck, which, like the abundant Scoter, haunts those portions of the estuary near the mouth in winter but seldom ascends far on the tide. The Long-tailed Duck is merely a straggler. Divers, Grebes and Mergansers come at times, but are useless to the fowler.

The estuary abounds in waders—the Curlew, Oyster-catcher or "Sea Pie," Knot, Dunlin, Sanderling, Ringed Plover and Redshank are the most numerous, and the Whimbrel and Bar-tailed Godwit are not uncommon on passage, but the latter bird is very irregular in its visits. The flights of Knots, or "Duns" as they are locally called, are often immense, but by day the birds keep to the banks near the mouth of the river. At night they sometimes feed up the river, and then the music of their combined voices, countless thousands talking in the darkness, is most weird and interesting.

The Peregrine is hardly a fowler's bird, but he waits on the puntsman, and often gives him a splendid exhibition of natural falconry when he stoops at some swiftly flying Teal or Homer Pigeon which is crossing the marsh. Often, when we have fired the punt-gun, a Peregrine has dashed in and claimed a cripple before we could gather it ; on one occasion three of these splendid falcons came down after a shot and each went off with a Silver Plover.

The puntsman who takes an interest in nature, and every true sportsman is a naturalist, sees many sights on the wide river. At times birds on passage—Larks, Starlings, Meadow Pipits and Thrushes—cross the estuary, sometimes singly, sometimes thousands together, and when a strong wind is blowing one will occasionally rest on the deck of the punt before continuing its flight across the water. I once saw a Thrush alight two or three times on the water for a rest, and eventually reach the further shore in safety, but the passing migrant, like the crippled duck, has to run the gauntlet of the ferocious Great Black-backed Gulls which haunt the river ; I have seen a small bird captured in flight by a Gull. Strange things happen to the Dee puntsman ; once a Hare was taken aboard when it was swimming a gutter into which it had been driven ; once Brooke shot a Porpoise, but failed to land it owing to rough weather, and once he found a stranded Grampus dead. We captured a Salmon, a fine fish, which had been left in one of the "gorings," and found at different times a Ling of about fifteen pounds, a huge Devil Fish or Angler, and the body of an unfortunate man from the ironworks, who, when out shooting on the previous day, had lost his way in the fog and perished in the tide.

Anyone who takes an interest in this most fascinating and healthful sport, full though it is of hardships and disappointments, cannot do better than consult the admirable writings of Sir Ralph Payne-Gallwey, *Moor and Marsh* in the Badminton Library, *Letters to Young Shooters*, Series 3, and *The Fowler in Ireland*, and Abel Chapman's *Art of Wildfowling* and *Bird Life of the Borders*. Does he wish to consult the first oracle and gather knowledge at the *fons et origo* of fowling, let him turn to the ninth edition of Colonel Peter Hawker's *Guns and Shooting*, which, though written about seventy years ago, still remains the classic of the sport.

THE REPTILES AND AMPHIBIANS OF CHESHIRE

THE REPTILES AND AMPHIBIANS OF CHESHIRE.

INTRODUCTION.

Although two out of the three British Snakes, the two Lizards and the Blindworm, occur or have occurred within recent years, Cheshire has a remarkably poor reptilian fauna ; no single species can be called common. Even on the moorlands, which are apparently suitable for the Viper and Common Lizard, the former is exceedingly rare and the latter nowhere abundant. Amphibians, however, are plentiful, the humid climate and abundance of water suiting their requirements ; the Frog and both Toads and the three Newts occur. The presence in former years of the Sand Lizard on the Wirral coast, which, except in a narrow strip of similar country in Lancashire, is not found elsewhere in the north of England, and the occurrence of the exceedingly local Natterjack, are worthy of special notice.

REPTILIA.

SAURIA *LACERTIDAE.*

Sub-order *LACERTILIA.*

COMMON LIZARD. *Lacerta vivipara*, Jacquin.

Local name—SWIFT.

Widely distributed, but nowhere abundant.

The Common Lizard occurs in many localities in Cheshire, and is commoner than elsewhere on the mosses and heaths. It is found on the coast sandhills, and formerly occurred on Bidston Hill* and in other Wirral localities. In Delamere Forest it is not uncommon on open heaths, such as Little Budworth Common, Newchurch Common, Abbot's Moss and Flaxmere, and it haunts similar situations in other parts of the plain. It occurs on the moors in the east of the county ; we have found it at over fifteen hundred feet near the "Cat and Fiddle." Before Carrington Moss was reclaimed in 1886 it was plentiful, and a few still linger in this district ; one was taken so recently as the spring of 1908.

The Common Lizard is ovoviviparous, but, in captivity at any rate, the young do not invariably escape from the egg-capsule during oviposition. Mr. G. A. Dunlop, on August 5th, 1907, caught a gravid female at Flaxmere, and on August 19th it laid ten eggs. He concluded from their appearance when he first noticed them that they had not been long deposited, and, as they were adhering in a mass, that they had been laid consecutively. Ten minutes later the first young Lizard escaped from the capsule.

* Byerley, p. 24.

The young first wriggled violently in the egg and then became still, apparently resting a moment before bursting the skin at the top of the egg; the head of the Lizard appeared first. The emergence was gradual, the Lizard resting several times before it got entirely free. The eyes of two or three of the young were either closed or covered with a milky membrane when they emerged, but those of the majority were open. An hour elapsed between the hatching of the first and the last egg. From two of the eggs, plunged into spirit, the young freed themselves by rupturing the capsule in their struggles.

SAND LIZARD. *Lacerta agilis*, Linné.

Formerly not uncommon on the coast sandhills, now probably extinct.

The Sand Lizard was formerly common on the sand-dunes bordering Liverpool Bay from Southport to Formby in Lancashire and from New Brighton to West Kirby in Cheshire. Byerley speaks of it in 1856, and Mr. Linnaeus Greening is of opinion that some of the specimens in his collection, now in the Warrington Museum, were obtained in Cheshire; he remembers the late C. S. Gregson showing him examples that had been captured at Wallasey. The character of the Cheshire coast has been much altered in recent years, but along the Lancashire shore a considerable area is still covered by dunes which are exempt from the golfer, and there the Sand Lizard is still to be found. In Cheshire, however, the growth of New Brighton, Wallasey, Hoylake and West Kirby, the conversion of the sandhills in many places into golf-links, and the occupation by summer camps of the land behind the Leasowe Embankment, has curtailed the area in which the Sand Lizard formerly occurred, and we have not heard of its occurrence within recent years.*

* *Cf.* T. A. C., *Zoologist*, 1901, pp. 355, 356.

ANGUIDAE.

BLINDWORM. *Anguis fragilis,* Linné.

Local names—SLOW-WORM ; ASKER ; LONG-WORM.

Rare, but widely distributed.

The Blindworm, although it occurs in many widely separated localities in Cheshire, is not at the present day common. Bidston Hill is mentioned by Byerley* as the one Wirral locality where he knew it to occur, but there is an earlier and curious reference to it in an article about Bromborough in the *Gentleman's Magazine* for 1762† :—

"A kind of reptiles, called by the inhabitants '*long-worms,*' is very common here in the sandy lanes and hedges ; and a poor girl, who lived here once, fed one of them, which became so tame as to creep round her arm, and receive its food from her without injuring her."

There are few "sandy lanes" now at Bromborough, but the Blindworm still exists in the district ; Mr. G. A. Dunlop found it there in 1904. It has probably vanished from Bidston Hill; and even on Heswall Hills, where we found it in May, 1894, most of the open country is built over. At Thurstaston and a few other places on the Wirral hills there are uncultivated areas where no doubt a few remain.

The late Lord de Tabley spoke of the Blindworm as common at Holford Moss, and mentions one taken in Tabley Park,‡ and in 1882 the late J. F. Robinson described it as common at Overton, Frodsham, where the boys knew it as the "Asker."§ Mr. Linnaeus Greening refers to it as

* Byerley, p. 24.

† p. 616.

‡ *MS. note-book.*

§ *Manchester City News,* November 4th, 1882.

THURSTASTON COMMON, WIRRAL.

"often found by platelayers on the line between Knutsford and Chester,"* and Mr. Newstead has seen it at Helsby and Delamere. At the present day, however, it is seldom met with, though within the last few years we have seen it at Castle Mill near Ashley, Mobberley and Styal. Mr. F. Stubbs says that it is not uncommon at Broadbottom in the east of the county.

OPHIDIA — *COLUBRIDAE.*

Sub-order *COLUBRIFORMES* — Sub-family *NATRICIDAE.*

RINGED SNAKE. *Tropidonotus natrix* (Linné).

Rare in Wirral and the plain.

In 1856 Byerley described the Ringed Snake as "not uncommon, though less frequent in Wirral now than formerly," and the late Lord de Tabley, recording one taken at Tabley in 1860, said that the species had been seen occasionally in former years.† The growth of population and the reclamation of waste places, coupled with the unreasoning destruction of every snake by the ignorant, probably explains the rarity of the Ringed Snake in Cheshire today. It is most abundant about Delamere and in western Cheshire—we saw one at Oakmere so recently as 1904—and from time to time one hears of snakes being killed in various places. There are several Ringed Snakes from west Cheshire in the Grosvenor Museum, and one, a female, from Hough Green, Chester, measures thirty-three inches in length; Mr. R. Newstead tells us that he has met with the species at Aldford, Ince, Helsby and Delamere. We have seen Ringed Snakes which were killed many

* *Naturalist*, 1886, p. 81.

† *MS. note-book.*

years ago near Congleton and Wincle ; one was taken at Wythenshawe near Northenden in the eighties, and several have been seen, captured or killed within recent years in the neighbourhood of Bowdon and Hale, and in the Bollin Valley, where one was caught about the year 1905. So many Ringed Snakes, however, are now kept in vivaria that there is always a suspicion that one seen near houses may have escaped from captivity.

VIPERIDAE.

Sub-order *VIPERIFORMES.*

COMMON VIPER. *Vipera berus* (Linné).

Local names—ADDER ; HETHER ; ETHER.

Formerly not uncommon on the mosses ; now rare.

The Viper was common on the Cheshire mosses before their reclamation, and, though it has vanished from many of its former haunts, it still lingers in Delamere Forest and perhaps elsewhere. On Carrington Moss it was fairly abundant in the eighties, and several were killed so lately as the summer of 1893, but this was perhaps one of its last strongholds in the plain. In Wirral, where it was recorded from Leasowe by Byerley, and Eastham Wood in 1862 by Moore,* it is now probably extinct, unless a few linger on Thurstaston Common and similar spots where there is open heathy ground still unbuilt upon. Only two are recorded by the late Lord de Tabley, one at Rudheath in 1863 and the other at Peover in 1864.† Mr. Linnaeus Greening mentions it at Delamere in 1886,‡ and on July

* *Liverpool Naturalists' Field Club, Report,* March 16th, 1863.

† *MS. note-book.*

‡ *Naturalist,* 1886, p. 81.

8th, 1893, Mr. R. Newstead examined one that had been killed a day or two previously in the Forest. There is a Viper in the Warrington Museum that was captured on Foxhill, Frodsham, on July 27th, 1890, and on May 1st, 1909, a large example, now in the Grosvenor Museum, Chester, was captured on Abbot's Moss.

On the Longdendale moors and the hills east of Macclesfield, where one would expect to find it common, it is hardly known by the gamekeepers and shepherds ; indeed we have only heard of the capture of one Viper in Cheshire within the last ten years.

BATRACHIA.

ECAUDATA *RANIDAE.*

COMMON FROG. *Rana temporaria*, Linné.

Common throughout the county.

The Common Frog is abundant in all parts of Cheshire, occurring even on the high moorlands. Frog-spawn, which in some parts of the county was formerly known as "toad-rudd,"* may be found from the middle of March to the beginning of April, and tadpoles, locally known as "bull-heads," are common in spring in the marl-pits, meres, and ditches on the marshes.

Bell states† that "Frogs retire, on the approach of winter, to their hibernating retreats, where they pass the dreary season in a state of absolute torpidity. This is generally in the mud at the bottom of the water, where they are not only preserved in a nearly equal temperature, though at a low degree, but also secured from external injury." This statement is repeated in many modern accounts, but it is not strictly accurate. Boulenger says that they "do not fall into complete lethargy,"‡ and Mr. C. B. Moffat has shown that in Ireland the hibernation of the Frog is frequently interrupted.§ Coward observed in the winter of 1909-10 that several Frogs which were spending the colder months in a disused pit in his garden were lively except during severe frost, and that even when torpid they

* Holland, *Glossary*, p. 364.

† *British Reptiles*, p. 94.

‡ *Tailless Batrachians of Europe*, Vol. I., p. 59.

§ *Irish Naturalist*, 1904, pp. 81-87.

were roused by being handled in the course of a few minutes. Towards the end of December, 1909, Mr. N. Neave noticed a number of Frogs in a small shallow pond in his garden at Rainow near Macclesfield, where as a rule he only sees them in the water during the breeding season in spring. On the night of the 18th there was a keen frost, but for a day or two he could see the Frogs crawling about the bottom of the pond below the ice. Subsequently the water froze to the bottom, and when it thawed in January, 1910, the animals which had been actually frozen into the ice were found to be dead. He has on no previous occasion noticed Frogs in this pond in December or January.

The Frog, like some other batrachians, has the power of adapting its colour to correspond with its environment. On November 10th, 1898, a remarkably light-coloured Frog was found on the concrete floor of a cellar at Alderley Edge; it was pale yellow with a few greenish spots on the upper surface. When placed in a glass dish upon a black surface in a dark room, where but little light could influence the change, it was appreciably darker in three hours. In daylight next morning the upper parts were a uniform dark brown and the greenish spots were entirely merged in the dark colour. On the evening of the 11th the glass dish was placed on a white plate, and in three hours, although again in darkness, the Frog had resumed its light appearance. By the following morning the greenish spots had almost disappeared on the back, though still discernible on the legs, and the general colour was paler than when it was first found.

In Cheshire, as in other parts of England, the placing of a living Frog in the mouth of a child is considered a cure for thrush.*

* *Science Gossip*, April 1, 1865.

BUFONIDAE.

COMMON TOAD. *Bufo bufo* (Linné).

Local name—TUMMUZ (Thomas).*

Common in all parts.

The Common Toad is generally distributed throughout Cheshire, and is everywhere abundant ; it occurs alike on the Wirral coast, in the cultivated plain, and on, at any rate, the lower hills in the east.

The Toad spawns early in April, perhaps a little later than the Frog. On April 11th, 1898, Toads were spawning in a feeder at Bosley Reservoir, and on April 18th, 1885, at Cheadle, but occasionally they pair at an earlier date, for in 1888 they were spawning in a pond at Mobberley on March 10th.

There is a widespread belief that old Toads are strangled by the younger ones—behaviour which is supposed to be in keeping with its evil character and at the same time a wise " provision of nature " to prevent the undue increase of a noxious creature which appears to have but few natural enemies. There is considerable disparity in the size of the sexes, and the posture of the smaller males—described as the two-year-old Toads—at the spawning period suggests that they are throttling the larger—the so-called three-year-old—females.

NATTERJACK TOAD. *Bufo calamita*, Laurenti.

Formerly abundant on the coast sandhills ; now very rare, if not extinct, in many of its former haunts.

The Natterjack Toad occurs along the shores of Liverpool Bay from the Ribble to the Conway, but though it is still

* Leigh, *Glossary*, p. 215.

plentiful on the Lancashire sandhills near Southport, and occurs in North Wales between Prestatyn and Llanrwst,* it has suffered in Cheshire from the destruction of its haunts, and in most localities is now rare, if indeed it still survives. In the eighties and early nineties the Natterjack was abundant on the Wallasey sandhills, frequenting the shallow pools in the hollows amongst the dunes, where, in 1886, even so late as August 2nd, we found tadpoles and young Toads. The dorsal stripe was plainly marked in the young Toads, which had absorbed most of the tail, but was not visible in the tadpoles. In April, 1893, Mr. R. Newstead found it plentiful at Wallasey, and obtained a number of adult Toads from their burrows in the sand. When these sandhills were converted into golf-links most of these pools were drained. On several occasions recently we have failed to discover a single Natterjack at Wallasey, but on the low-lying land behind the Leasowe Embankment it is still abundant. Here, on September 17th, 1909, Messrs. L. Greening and C. Madeley found many old and young Toads beneath piles of stones. In 1854, Byerley says, one was taken between Egremont and New Brighton, and in 1851 one at Oxton Hill; these localities have long been unsuitable habitats by reason of building and reclamation.

The croak of the Natterjack is loud and continuous, sounding from a distance something like the "churr" of the Nightjar; on the Lancashire coast the Toads are known as "Bootle Organs" on the north side of Liverpool, and as "Southport Nightingales" in the neighbourhood of that town, but we have not heard any similar local name in Cheshire.

* Forrest, *Fauna of North Wales*, p. 427.

CAUDATA *SALAMANDRIDAE.*

CRESTED NEWT. *Molge cristata* (Laurenti).

Local names—ASK ; ASKER ; AZZLE.

Common throughout Cheshire.

The Crested Newt occurs in marl-pits throughout the Cheshire plain, but is not so abundant as the Common Newt. During immaturity and after the breeding season it may be met with under logs or amongst leaves in dry ditches, sometimes at a considerable distance from water.

Together with the other two species of newt, it is locally known as the "Asker," but perhaps more than the others is reputed to possess venomous qualities, and even to spit fire.

COMMON NEWT. *Molge vulgaris* (Linné).

Local names—ASK ; ASKER.

Abundant throughout.

The Common Newt is abundant in marl-pits and ponds in all parts of the lowlands during the breeding season. Immature Newts, during the long period that elapses between their leaving the water and returning to it as adults to spawn, frequent dry ditches and banks, cellar grids, crevices in stone walls, and similar situations. At this stage they are often miscalled "Lizards," but "Asker" is the ordinary name for this as for other species of newt in Cheshire.

PALMATED NEWT. *Molge palmata* (Schneider).

Not uncommon in eastern Cheshire ; reported from Wirral.

Byerley states that three Palmated Newts were caught "in a clear shallow stream at Upton, in 1851," but we have not observed the species in Wirral, nor heard of its occurrence since that date. In the east of Cheshire, however, it is not uncommon, and to a great extent replaces the Common Newt in many localities. We have examined specimens from Mossley and Stalybridge, and have seen it in ponds at Dukinfield, and at Compstall, Romiley and Marple in the Goyt Valley. Mr. Linnaeus Greening has obtained it at Walton near Warrington.

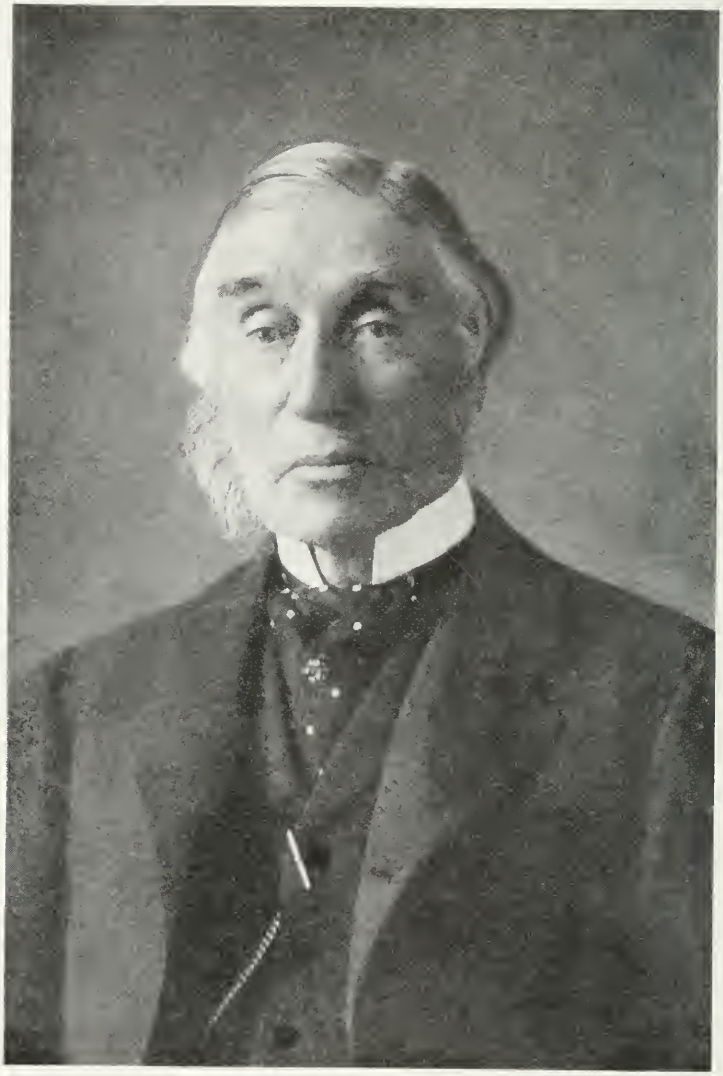
At the beginning of March males in the ponds scarcely show the caudal filament associated with the breeding season, but by the end of the month it is fully developed. At Dukinfield we have seen larval Palmated Newts at the beginning of July.

The Palmated Newt, like the Common Frog and other batrachians, undergoes chameleonic colour changes of a protective nature, as is shown by the following account of some rough experiments. On the evening of June 13th, 1895, Oldham took two females from a pond at Romiley. One (*a*), which was resting on black mud, was dark green, and the markings on its skin were hardly discernible ; the other (*b*) was pale greenish-yellow and clearly showed the characteristic markings of dark green ; it approximated roughly to the colour of the yellow clay at the bottom of the pond. At 8 p.m. both Newts were placed in water in a glass dish standing on a white plate. At 8 a.m. on the 14th both were much paler, *a* being almost as light as *b*. At 7 p.m. the colours of both were identical. *B* was then transferred to a dish standing on black cloth ; at 1.45 p.m. on the 15th it had become even darker than *a* was when taken from the pond, and by 5.30 p.m. the colours had further deepened. *B* was then restored to the dish on the

white plate, and *a* was placed in the dish on black cloth. At 8.10 p.m. *b* was noticeably lighter than *a*, and by 9 a.m. on the 16th the position was exactly reversed from what it had been at 5.30 p.m. the day before ; that is to say, *a* was now at the darkest, *b* at the lightest pitch. Both Newts were then placed in the dish on the white plate, and the dark *a* quickly changed colour, being at 10.30 a.m. scarcely deeper in tone than *b*. At 1 p.m. the two were indistinguishable except by size. The changes were only apparent in the colour of the dorsal surface ; the light ventral surface, which is unexposed to the view of enemies of the Newt in its natural state, remained unaltered.*

* C. O., *Naturalist*, 1895, p. 219.

THE FISHES OF CHESHIRE AND LIVERPOOL BAY



JOHN FELL, ESQ., J.P., [19]*

Chairman of the Lancashire and Western Sea-Fisheries Joint Committee, 1889–1904.

THE FISHES OF CHESHIRE AND LIVERPOOL BAY.

INTRODUCTION.

THE CHESHIRE SEA AREA.

An obvious difficulty encountered in considering the fauna of a small sea area, such as that adjacent to the coastline of a single county, is that marine organisms as a rule are widely distributed. Most fishes are actively swimming animals and in the course of their life-history roam over relatively large tracts of sea. Even such sluggish or sedentary creatures as mussels, cockles, starfishes, sea-urchins and zoophytes possess adequate means of distributing themselves, for they produce pelagic eggs and larvae. Though these animals live for the greater part of their lives on a comparatively small patch of sea bottom, or even actually attached to it, their spawn becomes widely disseminated by the action of tides, currents, or the surface drift of sea water. Most of the fishes inhabiting the Irish Sea produce large numbers of pelagic eggs which, being specifically lighter than sea water, float at, or near to, the surface of the sea, and so may be carried great distances. Thus Liverpool Bay contains fishes, such as the Cod, Herring, Mackerel, Bass, Garfish and others, which may have migrated into it from outside the Irish Sea; while many others found in the Cheshire sea area, such as the Plaice, Sole, Brill, Turbot, Whiting and Haddock, live in the earlier stages of their life-histories as eggs and larvae in the offshore parts of the Irish Sea, or even in St. George's and the North Channels.

If lists of fishes known to occur in the sea off the coasts of North Wales on the one hand, and in the Firth of Clyde on the other, be compared, it will be seen that the great majority of species are common to both lists; and still greater similarity would be observed in a comparison of the marine fishes occurring in the territorial waters of adjacent counties, such as Cheshire, Lancashire and Cumberland. There would be little justification for an account of the fish fauna of the Cheshire sea area apart from that of neighbouring county waters if such an account included only a list of the species present, with notes as to their precise places of occurrence. I propose, however, to make an "intensive study" of the fishes present in the inshore waters of Liverpool Bay, endeavouring so far as possible to summarise what is known with regard to their density of occurrence, their breeding habits and cycles, their migration paths and periods; and also of the influence exerted upon their modes of distribution by the physical conditions prevalent in the Cheshire sea area.

LIVERPOOL BAY.

The geographical subdivisions of a coastal sea area, such as are expressed by county boundaries, do not usually coincide with those natural subdivisions determined by the configuration of the coastline, or by the nature and depth of the sea bottom. The Cheshire sea area, defined politically, consists of that part of the Irish Sea bounded by lines drawn down the centres of the estuaries of the Dee and Mersey, and by another imaginary line running parallel to the north coast of the Wirral Peninsula at a distance of three miles from low-water mark. But this is a purely artificial area, and it will be convenient to substitute for it a portion of that part of the sea known to mariners as Liverpool Bay. An imaginary line drawn from the Great Orme's Head in Carnarvonshire to Formby Point in Lancashire includes as much of Liverpool Bay as need be considered; physical and biological investigations show

SKETCH CHART OF THE CHESHIRE SEA AREA.

that this part of the sea is an area possessing well marked characters of its own. Westwards, towards the north coast of Anglesey, the characters of both sea bottom and coast-line change, and the fauna of Red Wharf Bay, Beaumaris Bay and the Menai Straits differs to some extent from that of Liverpool Bay ; while a less notable change takes place to the north, towards the estuary of the Ribble and Morecambe Bay.

The general characters of Liverpool Bay, which are of importance in the consideration of its fish fauna, are as follows : It is a shallow-water sea, the depth in most places being less than ten fathoms ; the sea bottom consists predominantly of fine quartz sand ; rocky shores and *Zostera* beds are almost entirely absent ; there are high and strong tides, producing great rises and falls of the sea-level and rapid tidal streams ; the water is generally turbid because of the scouring action of these streams on the bottom deposits ; the specific gravity of the sea is low on account of the entrance of fresh water from the land ; and the annual range of temperature is greater than in the sea offshore.

THE SEA BOTTOM.

It is difficult without continual reference to large scale charts to describe exactly the topography of the sea-bottom, but the sketch chart on page 21 will probably be sufficient for present purposes. The district is characterised by the presence of the two great estuaries of the Dee and Mersey, and by the extensive sandbanks lying outside the openings of these arms of the sea. The estuary of the Dee is funnel-shaped, the mouth facing the sea. Between Air Point and Hilbre Island its width is about four and a half miles, and it contracts gradually to the south. At high water of a spring tide the eye rests on an evanescent sheet of water, at low water on the desolate "Sands o' Dee." By far the greater part of the estuary consists of sand-flats, daily exposed on the ebb tide, with narrow, tortuous and shifting channels between them.

Even at high water these channels suffice only for the navigation of fishing boats and shallow-draught coasting vessels. The estuary at Connah's Quay is about three miles wide at high water, and its area from there seaward is about fifty square miles, of which about three-fourths is sand and mud at low water. The river Dee itself drains an area of about 490,780 acres, bearing a population of about 190,000 souls. It is a tidal river to above Farndon Bridge, but all ordinary tides are stopped at Chester Weir.

The estuary of the Mersey is bottle-shaped, and the neck of the bottle, represented by the river between Liverpool and Birkenhead, is turned towards the sea. Its area is about twenty-five square miles. Between Liverpool and Birkenhead the width of the estuary is only about three-quarters of a mile, but towards Eastham it expands to about three miles, forming an extensive, very shallow water-basin. The "bottle-neck" is very deep—from fifty to seventy feet at low water of an ordinary spring tide—so that even large steamers can ride at anchor between Seacombe and New Brighton at all states of the tide; it is also relatively deep on the Cheshire side towards Eastham. Immediately above the Liverpool landing stage, on the Lancashire side, it is shallow, and sandbanks characterise its upper reaches, making navigation difficult except for shallow-draught vessels. The river Mersey itself and its principal tributary, the Weaver, are small, shallow, highly polluted streams of little importance from a biological point of view.

Extensive sandbanks lie seawards from the openings of the Dee and Mersey estuaries. These are represented on the sketch chart by the dotted areas, and it will be seen that the entrance to the Dee is nearly obliterated by the East and West Hoyle Banks. East Hoyle, which runs out to sea nearly due north, is a continuation of the sands, Mockbeggar Wharf, which fringe the north shore of the Wirral Peninsula. West Hoyle lies to the western side of the Dee. Between the two is the Eastern Channel, which

curves round north of Hilbre Island, and then across to the Welsh side of the estuary. Between Air Point and West Hoyle is the Western Channel of the Dee. Continuations of these channels lead up the estuary towards Parkgate and Heswall on the north and Connah's Quay and Chester on the south. The smaller channels form precarious waterways which are used only by fishing boats and coasting craft.

The estuary of the Mersey is approached by three channels. The narrowest of these, Formby Pool and Channel, runs along the Formby shore to the north and west and is used only by small vessels. The Rock Channel is also narrow and is not used by large vessels. It runs from New Brighton roughly parallel to the Wirral coast and then seaward to the north as the Horse Channel. At its New Brighton end it is shallow owing to the Rock Bar. The main Mersey Channel is much deeper and wider than either of these, and bears the leviathans of ocean traffic. Beginning as the Crosby Channel, which is a direct continuation of the deep water between Liverpool and Birkenhead, it bends to the west and runs seaward as the Queen's Channel, its distal part being formed by the dredged cut through the Mersey Bar. Formerly the depth of water on the bar was not very great, but continued dredging operations and the scour of the tidal streams have now made it deep enough to allow the largest vessels to pass over it at almost all states of the tide.

Between these various channels there lies a series of sandbanks—Great and Little Burbo, Spencer's Spit and others. The Burbo Banks and Flats and Spencer's Spit lie between the Queen's and Crosby on the north and the Rock and Horse Channels on the south and west. Taylor's Bank lies between the Queen's and Formby Channels; along the west side of Taylor's Bank the Liverpool Dock Board propose to build a training wall. Formby and Crosby Sands lie between Formby Channel and the Lancashire coast; Mockbeggar Wharf between the Rock Channel and the

Cheshire coast. Through and between these various sandbanks there are smaller channels and gutters, but these are neither buoyed nor navigable. Their exact depths and positions are inconstant; they are known only to the fishermen, who trawl in them and along the margins of the larger channels and banks. Great changes have taken place in the configuration of the Dee and Mersey channels and banks, even within the recollection of persons now living. The approaches to Hoylake, for instance, have greatly changed, and the town may soon cease to be a seaport.

TIDES.

The existence of these extensive sandbanks and flats, the shallow sea, and the greatly eroded coastline, indicates that Liverpool Bay is characterised by high and strong tides. Two tidal undulations enter the Irish Sea. If a chart of the co-tidal lines, such as may be found in text-books on physiography, be consulted, it will be seen that the Atlantic tidal undulation splits into three sub-waves as it approaches the west coast of Ireland. One of these passes up the Channel, and being reflected at the narrow Straits of Dover produces complicated tidal effects. Another wave runs up the Bristol Channel, and gaining amplitude as that estuary shallows and narrows, gives rise to the high tides of the Severn. The third sub-wave enters the Irish Sea through St. George's Channel. The remainder of the Atlantic tide, impinging on the south-west coast of Ireland, passes obliquely to the north, and rounding the north of Scotland enters the North Sea. Part of this wave, however, enters the Irish Sea through the North Channel.

Two tidal waves therefore, from the north and south, enter the Irish Sea. Because of the deeper and wider entrance afforded by St. George's Channel it is the south tide which is the more important of the two. These two tides meet and interfere with each other at the latitude of

the north of the Isle of Man ; a line drawn from Maughold Head in Mona to Morecambe Head in England represents what is known to seafaring men as the "head of the tide." South of this line the flood stream runs to the north-east, and north of it the flood runs to the south-east. Between the Isle of Man and Ireland the two tides also interfere with each other, so that there is practically no stream there, the water simply rising and falling. Owing to the greater volume of the northerly flowing tide and to the prevalence of south to west winds, there is a general drift of water in the Irish Sea from south to north, and therefore a flow outwards through the North Channel, the volume of which has been estimated. So well is this northerly drift known to longshoremen and coasters that when a vessel is wrecked and breaks up in Liverpool Bay, the wreckage is actually looked for off the coast of Cumberland. Most fishermen recollect the loss of a large vessel off the Mersey in 1904, and the finding of a part of its cargo of sherry, raisins, almonds and soap in Morecambe Bay. The northerly drift of Irish Sea water is a factor of very great importance in the determination of the nature and abundance of the marine life present in the Cheshire sea area.

If a bathymetrical chart of England be consulted, it will be seen that all along the west coast the sea is relatively shallow. Between the Irish coast and the Isle of Man there is a deep channel, the depth varying from about fifty to eighty fathoms ; east of the island the sea is much shallower. Geologically the sea to the east of the Isle of Man is an extension of the low-lying Lancashire and Cheshire land, while the sea bed to the west is a submerged river valley. Currents and tidal streams tend to flow along the deeper parts of the sea bottom, but because of "Ferrel's Law" and the nature of the coastline, the Irish Sea flood streams tend to become deflected to the east. The north and west coasts of Anglesey consist of durable iron-hard rock, while those of Lancashire and Cheshire, made up of much softer materials, are easily eroded. The flood streams

impinging on the coast of Anglesey have done but little harm, but they have denuded the much softer land forming the coast of Denbigh, Flint, Cheshire and Lancashire ; the sea bottom off the last-named counties is therefore a "plain of marine denudation."

Such a shallow sea increases the amplitude of the tides and the velocity of the tidal streams. The rise and fall in St. George's Channel does not exceed five to twenty feet, and the velocity of the stream varies from two to four knots ; but as the tidal wave enters the shallow inshore part of Liverpool Bay its amplitude and velocity increase. The extreme rise and fall in the Mersey may exceed thirty-three feet and the flood stream may run, at high spring tides, with a velocity of seven knots. The difference in the shapes of the estuaries of the Dee and Mersey is the cause of the great difference in the depth of water at the entrances to those inlets. The width of the Dee decreases gradually as we pass inwards from the sea, with the result that the flood stream increases in force as it passes up the estuary ; while the ebb stream decreases as it flows from Chester to the sea. Suspended matter is therefore laid down at the mouth of the Dee as the stream slackens, producing a shallow sea bottom. The mouth of the Mersey, on the other hand, is narrow, and the width increases inward from the sea. At the time of high tide an enormous volume of water is therefore impounded in the upper reaches of the estuary, and when the ebb begins the stream rushes out through the restricted channel between Liverpool and Birkenhead with great force, scouring out the bottom of the river. Outside a line from Seaforth to New Brighton, however, the velocity of the ebb stream slackens, and the suspended particles are laid down, producing the Mersey banks and bar.

At low water—when the banks are exposed—they form a natural breakwater, and the estuary of the Mersey is then comparatively calm. But at high water the banks are covered by the sea, and when a strong north-west wind

is blowing and encountering an ebb tide, an exceedingly turbulent sea is experienced, even off the Liverpool landing stage. Navigation of the estuary then becomes troublesome, and vessels lying at anchor off Egremont and New Brighton are exposed to a dangerous seaway. Violent storms and tides have very significant effects so far as the distribution of fishes is concerned. Strong tides and the resultant turbidity of the bottom water lead to minor migrations of demersal fishes, and affect the results of trawling operations. Heavy gales force ashore fish which may afterwards become stranded by high tides; several records of the occurrence of rare fishes are due to these causes.

SEA BOTTOM DEPOSITS.

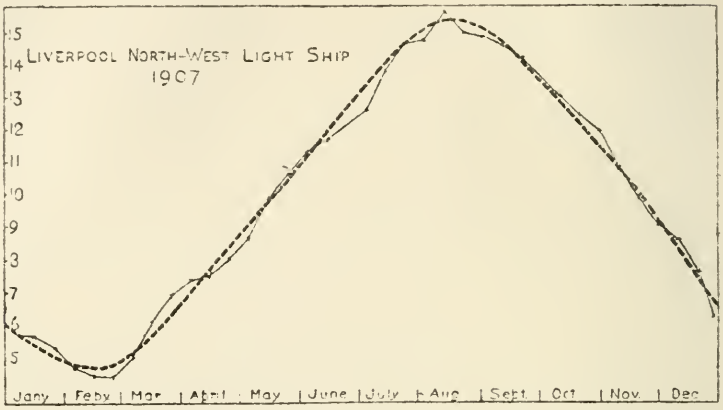
The strong and rapid tides and the soft and yielding nature of the land formations have resulted in a general uniformity of bottom deposits in the Mersey and Dee sea areas. Practically the entire sea bottom consists of fine quartz sand. Here and there are small saucer-like depressions, which may contain stones or pieces of coal rolled along by the action of the tides and accumulated in these concavities. In sequestered spots there may be deposits of fine mud. Seaward from Deposit Buoy is an extensive tract of bottom where mud is the chief constituent, but this is due, to some extent at least, to the deposition of the dredgings from the Liverpool Docks and the Manchester Ship Canal. There are small areas of the sea bottom strewn with stones or gravel, but they are not characteristic of the Cheshire sea area. The typical laminarian zone hardly exists, but can be identified in the neighbourhood of Hilbre Island. Off Air Point, near the Dee Lightvessel, the ground is soft and muddy, but west from the ship the sea bottom is stony or "rough" for several miles, and here there used to be a certain amount of "prawning" for *Pandalus*. The bottom is also hard on some parts of the West Hoyle Bank, where mussels are to be found, off the

Wallasey shore between New Brighton and Egremont, and along to the west from New Brighton. There is a part of the bottom of the Rock Channel, opposite the Wallasey mussel-bed, where the bottom is covered by stones and weed. Round Hilbre Island the sea bottom is also rough, and there is stony ground in the Dee towards Caldy Where there are mussel-beds, as in the places mentioned, a regular cyclical change in the nature of the bottom recurs. The shellfish accumulate mud underneath them, and gradually the level of the sea bottom is raised ; at the same time it becomes much softer. After a time some unusually heavy gale produces a sea which breaks up the mussel-bed, rolling up the felted mass of mud and mussel shells like a carpet, and laying bare the hard ground beneath. Spat again settles down on the gravel or stones, and the mussel-bed is reformed. Sea bottom composed of organic remains, such as " knarr " ground, which is made up of the sandy tubes of the polychaete worm *Sabellaria*, exists only near Air Point. Shelly or coralline formations are absent. This sameness of bottom deposits, by presenting a general uniformity of conditions, leads to a similar uniformity in the distribution of the fish fauna, interesting in the extreme from a distributional and bionomical point of view, but, no doubt, disappointing to the naturalist and collector.

THE TEMPERATURE OF THE SEA.

Liverpool Bay presents distinct differences in temperature from the sea offshore. The temperature of the sea round the coasts of the British Isles is influenced by the drift of warm water which reaches these shores from the sub-tropical Atlantic—the Gulf Stream drift. Some distance from the west coast of Ireland the annual range of temperature of the sea is about 5° C. ; the maximum, 15° C., occurring in August, and the minimum, 10° C., occurring in February. Nearer the land this difference increases. Thus offshore from Cardigan Bay the annual range is about 10° C., the extremes of 17° C. and 7° C.

occurring in September and February. In Liverpool Bay the extremes are still further apart, as will be seen from the following diagram :—



The Sea-Temperature at Liverpool North-West Lightship in 1907. The irregular line represents thirty-daily averages taken every ten days. The thick broken line is smoothed from the other line and represents the annual wave of sea-temperature. (From *Lancashire Sea-Fish. Laby. Report* for 1908, p. 70.)

The curve reproduced above represents the temperature of the sea at the Liverpool North-West Lightship, and has been constructed from daily readings of the thermometer made for the Meteorological Office.*

The thin line is drawn through points which represent the "smoothed" ten-daily averages throughout the year. The value for the ten days at the end of March, for instance, is obtained by taking three averages, those for the middle ten days of March, the last ten days of March, and the first ten days in April ; and then calculating a new average from these three groups. This process is repeated for every ten-daily period throughout the year. The curve thus obtained represents the general character of the weather throughout the year as represented in the temperature of

* *Cf. Lancashire Sea-Fish. Laby. Ann. Rept.* for 1908, pp. 65–86, Liverpool, 1909.

the sea. The thick line is still further "smoothed" so that it represents the annual wave of temperature which sweeps over this part of the Irish Sea unaffected by the variations of weather from year to year.

In the year 1907 the minimum temperature occurred at the end of the second week of February and was 4.4° C. while the maximum was observed at the end of August, when the temperature was 15.8°. The annual difference in the middle of Liverpool Bay was thus about 11.4°. Nearer the land still greater extremes may be observed, and off the estuaries of the Dee and Mersey the sea temperature may fall as low as 3° and rise as high as 17°, an annual range of 14°.

When the variations from day to day are examined it is seen that the temperature changes notably within periods of a few days, a fact of the very greatest importance in discussing the causes of fish migrations. A curve representing these small fluctuations is very "jumpy," and the investigation of the causes of these lesser irregularities is difficult; but the main causes are the tides and the continually changing velocity and direction of the wind. It is possible to make out a periodicity of temperature change, the periods being fortnightly, and this suggests a connection with the fortnightly rise and fall of the tides. During the summer months the land is warmer than the sea, and the extensive sandbanks off the mouths of the estuaries are then exposed to the atmosphere twice a day, and are warmed slightly above the normal. When next they are covered by the flood tide the water is also warmed above the normal. The water of the ebb is therefore slightly warmer in the summer than that of the flood. In the winter the reverse is the case, for then the banks are a little colder than the sea and cool the flood water flowing over them, so that the ebb water is the colder. In this way alternating masses of water of slightly different temperature surge to and from the land. The direction and force of the wind are also factors of some importance, for a wind blowing towards the land from the open sea in the

summer drives before it a certain mass of water which is slightly colder than the water near the land, while a wind blowing from the shore towards the open sea drives before it water which is slightly warmer than the water off shore. In the winter these changes are reversed. Further, the entrance of fresh water from the land affects the temperature of the sea, for fresh and salt water have seldom the same temperature. These inshore and offshore currents carry with them floating particles, such as the eggs and pelagic larvae of fishes, and thus lead to a constantly varying distribution of these organisms.

The sea immediately off the mouths of the Dee and Mersey estuaries is colder during the winter months than any other part of the Irish Sea. This is owing to the cooling effect produced by the entrance of cold fresh water from the high land in North Wales; and because the sea in Liverpool Bay is comparatively sheltered from the warmer south to west winds. In the summer the temperature all along the shallow water from the Dee to Morecambe Bay is high and fairly uniform.

SALINITY.

A knowledge of the variations in the density of sea water is of great importance in discussing the variations in abundance of fishes and other marine animals. The *density* of sea water is the number representing the weight of a unit volume at the temperature *in situ*, when the weight of a similar volume of distilled water at the temperature 4° C. is taken as unity. The density of the water of the Irish Sea fluctuates round the value 1.025, but very considerable variations are to be observed. I have found densities of 1.017 in the water of the Crosby Channel, and still lower densities may be observed in the upper reaches of the Dee Estuary. It is more convenient to consider the *salinity* of the sea than the density, for we can then compare the water of our area with that of somewhat similarly situated sea areas elsewhere. The salinity is

the number expressing the weight of total dissolved salts (in grammes) contained in 1,000 grammes of sea water. In the region of the Gulf Stream drift, off the south-west coast of Ireland, the salinity is about 35.5, but near the land, and particularly in shallow seas and estuaries, the value of the salinity decreases. At the mouth of St. George's Channel it is about 35.0, and over the fairway of the Channel between Ireland and Wales it varies from about 34.8 to 34.5.

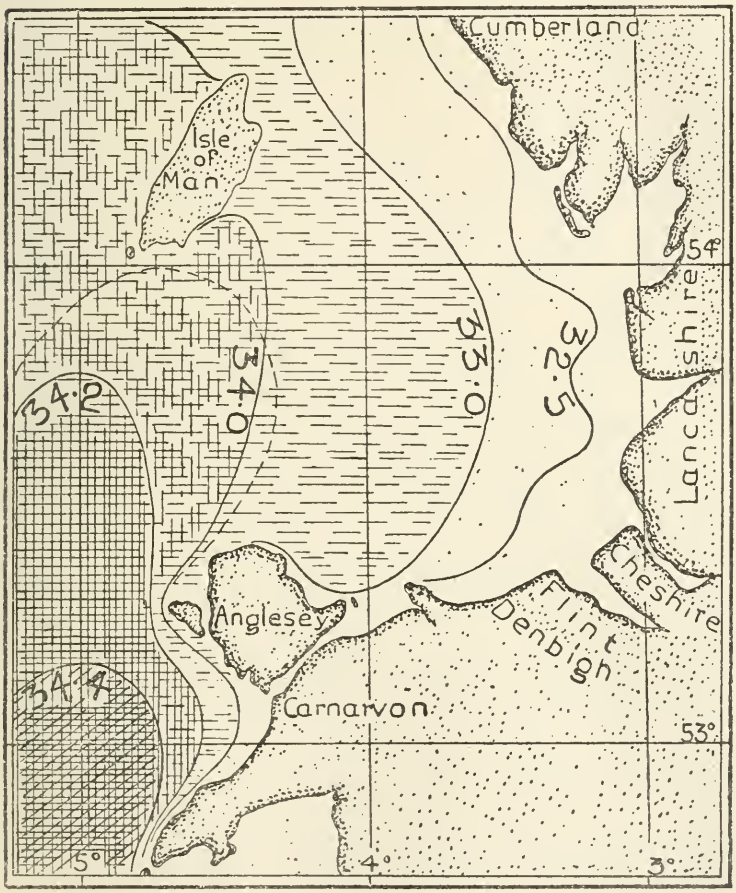
The salinity of the sea off the coasts of Lancashire and Cheshire has been investigated during the last three years by the Lancashire and Western Sea-Fisheries Committee; the results are of considerable importance in this enquiry. The variation in the density and salinity of the water of Liverpool Bay is due to two causes: (1) the variations in the strength of the Gulf Stream drift, and (2) the entrance into the sea of fresh water from the land. It is well known that the Gulf Stream current waxes and wanes in strength, being greatest in November and least in March. Because of this periodic variation in the strength of the true current there is a variation in the volume of the warm dense water reaching the shores of the British Islands as the drift set up by the Gulf Stream current. This drift is greatest in February and least in November. It enters the Irish Sea through St. George's Channel and not through the North Channel. Before it has reached Liverpool Bay it has been greatly diluted by the entrance into the sea of fresh water, so that the salinity, 35 and upwards, characteristic of the real undiluted drift water is never observed in Liverpool Bay; nevertheless the "pulse" of the Gulf Stream can be felt distinctly in the area, though it is of course feeble. The salinity of the sea along lines connecting Morecambe Bay with the Calf of Man and the Calf with Holyhead has been observed regularly every three months during the last four years; it has been found that different conditions are prevalent in these two parts of the Irish Sea. In the north the water is saltest during the summer and autumn, when there is least rainfall, and

freshest during February and March, after the period of greatest rainfall. As a rule the sea is saltest during the spring months in the southern area and freshest during the autumn ; a variation to be attributed to the greater strength of the Gulf Stream drift in the early part of the year. In 1907 the strength of the Gulf Stream drift was very slight ; in 1908 it was much stronger.

There is little doubt that there is an inflow of comparatively dense Atlantic water into the Irish Sea. Following the course of the tidal streams, this inflowing water sweeps up St. George's Channel and, rounding Anglesey very close to the land, enters Liverpool Bay. It does not, apparently, flow between the Isle of Man and Ireland. By the time it has reached the inshore waters of Liverpool Bay it has become diluted by water of land origin, and the rapid tides of this area soon mix up the water from the two sources, so that it is impossible to detect any seasonal change of salinity in the Cheshire sea area which can be attributed to the periodic variation in the inflow of Atlantic water. So far as our area is concerned, it is the influence of the wet country of North Wales that is mainly felt in the variation of salinity. Nevertheless this Atlantic inflow into Liverpool Bay is a fact, and its immediate significance is that by means of it the eggs and larvae of fishes living and spawning in St. George's Channel, and perhaps even further to the south, are transported into our area.

There are minor fluctuations in the density and salinity, just as there are minor fluctuations in the temperature. These small changes are due to the variable rainfall and the varying strength and direction of the tidal streams. A sudden freshet in the rivers of Cheshire and North Wales increases the volume of water entering Liverpool Bay by the Dee and Mersey, and this fresh water, being less dense than sea water, tends to flow on the surface as a thin sheet ; but soon the action of the tidal streams mixes the two constituents together, and irregular areas of diluted water are formed.

Isohalines, which are imaginary lines drawn on the surface of the sea, connecting together all points where a similar salinity has been observed, can be constructed, and I



The Salinity of the Eastern part of the Irish Sea in June, 1906–8. The curved lines on the sea-surface are isohalines, and the figures beneath them give the amount of total salts *per mille* in the water. The density of shading roughly indicates the salinity. The broken line near isohaline 34.0 indicates the furthest distance north and east to which the Gulf Stream Drift can be detected. (From *Lancashire Sea-Fish. Laby. Report* for 1908, p. 64.)

reproduce a figure which applies to the condition of the sea during June, 1908.

These isohalines run roughly parallel to the twenty-fathom contour line, and not so clearly parallel to the coast line. The 34 isohaline bends round Anglesey towards Liverpool Bay, but does not actually enter the Bay. The 33 line approaches nearer to our area. A great part of the Liverpool Bay water is much fresher than 33 per thousand. If we were able to complete the chart we should find that inside the 33 and 32.5 line there would be irregular and highly variable areas of sea where the salinity would vary from 33 to 30, whilst within the estuaries the value would fall even below 30, and would continually vary with the state of the tides and winds.

The changes of temperature and salinity to which I have referred in the previous pages are very small, and it might well be doubted that they could exert much influence on the migrations or growth of fishes. It is not at all easy to show that such comparatively small changes are of importance in this respect, yet there is no doubt whatever that they are. Fishery experiments prove well marked seasonal migrations of fishes into and out from Liverpool Bay. Regularly each autumn, as the sea temperature rises towards its maximum, the Cheshire shallow-water fishing grounds are invaded by hordes of small Whiting, and regularly each year these disappear as the temperature falls towards its annual minimum. Medium-sized Plaice appear on the fishing grounds immediately offshore from the Mersey and Dee in the summer and autumn ; Soles appear on the same grounds in the early summer. Plaice often appear in very great abundance in Red Wharf Bay and along the coast of North Wales, immediately west from the Cheshire area, in the late autumn—this part of the sea being then characterised by a rather higher temperature than the inshore part of Liverpool Bay proper. Cod come close inshore during the first and last months of the year just as the temperature is falling towards its minimum—to

be taken by the inshore liners. This migration is just prior to their annual spawning period. Enormous quantities of small Plaice and Dabs frequent the shallow water immediately adjacent to the coasts of Lancashire and Cheshire, and find there a suitable habitat during the first two or three years of their life-periods. All this is quite certain, and common knowledge among the fishermen, but just how to correlate these migrations with changes in the temperature and salinity of the sea water is one of the fishery problems of the immediate future. We know that salinity changes affect the osmotic concentration of the blood of fishes ; and we know that temperature changes affect the intensity of their metabolism. It is also certain that physical changes in the sea react on fishes indirectly by influencing the abundance of their food.

Plaice in Liverpool Bay, for instance, feed very largely on lamellibranch molluscs, such as the mussel and cockle, or common forms like *Tellina*, *Mactra*, *Scrobicularia* and *Solen* ; any conditions which favour the growth and multiplication of these bivalves must also favour the growth of the fishes which feed upon them. Occasionally a bed of young mussels is formed on the bed of the sea below low water as the result of some unusual set of the tides, which deposits the spat of the shellfish. When this happens young Plaice will congregate on the newly formed mussel-bed, feeding on the bivalves as long as they are of a suitable size. An unusual abundance of young Plaice in the Rock Channel during the autumn of 1908 was associated with a great abundance of small cockles and the sand-pipe (*Pectinaria*). These shellfish may grow up, or some unusual gale destroy the bed ; in either case the temporary shoal of Plaice will be dispersed. Now, the abundance of such animals as mussels and closely allied shellfish is affected by the food at their disposal, and this, which consists to a great extent of diatoms, is intimately affected by the physical factors, temperature and salinity. Mussels and cockles do not occur in abundance everywhere, but only

where there is a certain admixture of salt and fresh water a condition which is characteristic of the Lancashire and Cheshire sea area. Precisely how this dilution of the sea water affects the metabolism of the shellfish we do not know ; possibly the fresh water may contain dissolved substances—carbonaceous and nitrogenous compounds—which can be utilised as food by the shellfish. Perhaps the reduced salinity of the sea water is favourable to the multiplication of the microscopic plants and animals which can be used as food by the shellfish. It is characteristic of the shallow water off the coasts of Lancashire and Cheshire to a greater extent than any other area off the west coast of England that it should be invaded during the summer by enormous masses of the peculiar unicellular alga, *Halosphaera viridis*, Schmitz. Any one who has observed the shore in the neighbourhood of New Brighton in the early summer must have seen this organism as a yellowish-green scum on the sands and on stones, and noticed its peculiar "seaweedy" smell. It is a reasonable hypothesis that the regular seasonal abundance of this alga may be a factor of importance in producing the exceptional local abundance of Plaice and Dabs in the inshore waters of Liverpool Bay, for the molluscs may utilise as food the organic substance of the algal cells, or the carbonaceous compounds excreted ; and the shellfish themselves are eaten by the fishes.

There is no doubt that the enormous abundance of shrimps and crabs, which is characteristic of the sea off the two estuaries, is a factor of importance in influencing the abundance of fishes ; Skates, Rays, Gurnards and Cod prey upon these crustaceans. There is said to be a connection between the deposits of sludge, dock-dredgings and other refuse, which are brought down from the Mersey to be dumped on the grounds outside the bar and banks, and the abundance of young flat fishes, but I am not sure that the connection is very intimate. Very young flat fishes are abundant in Liverpool Bay because (1) there is a general easterly drift of surface water into this area from the open

THE DEE ESTUARY, GAYTON.

Irish Sea, and this surface drift carries into our area the eggs and larvae of fishes which have been spawned offshore ; (2) because the shallow warm sea off the coasts of Lancashire and Cheshire provides the physical conditions that are in some way essential to the development of the fishes in the early stages of their life-histories.

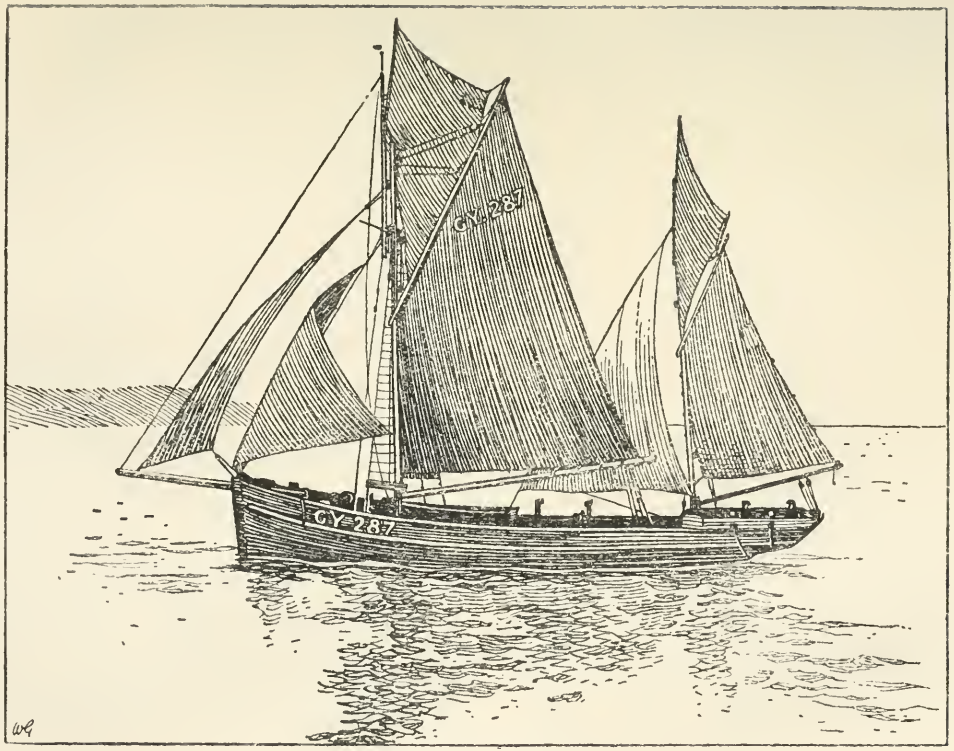
THE CHESHIRE SEA-FISHERIES.

The principal methods of fishing pursued in the county are (1) deep-sea trawling by first class fishing boats ; (2) inshore trawling by second class vessels for both fishes and shrimps ; (3) line fishing off New Brighton ; (4) stake-net fishing on the sands ; (5) fishing by means of "tees" and trammel-nets in the Dee ; and (6) musseling and cockling.

The estuary of the Dee is a boundary line separating areas characterised not only by very different physical conditions, but by peoples of strikingly different types. On the Cheshire side there are fishermen of the traditional English kind—hardy, industrious and venturesome ; making fishing their sole employment, pursuing it all over the eastern half of the Irish Sea and at all seasons of the year. On the Welsh side, on the other hand, there is a fishing population inconstant in their pursuit of the industry ; devoting themselves mainly to the "longshore" fisheries, shellfish-beds, fishing-weirs, and trawling in the estuaries and bays ; glad to avail themselves of other forms of casual employment, and rarely practising deep-sea fishing. It is the same difference that one sees between the east and west coasts of Scotland—the east with its leaven of the Scandinavian blood, loving the sea, venturing afar, following the industry in different regions as the seasons change ; and the west with its Keltic strain, clinging to the land, and reluctant to sever itself from its associations.

In Hoylake we have a traditional English fishing port,

with its fine fleet of smacks; such a centre as Brixham, Lowestoft or Fleetwood. The Hoylake vessels are the old fishing smacks, yawl-rigged vessels about sixty feet in length, and about forty tons in gross register. They carry beam trawls of about fifty feet spread, and steam capstans for hauling the nets and hoisting the sails. The crew of such a boat consists of four men, or three men and a boy. Nowadays most of the men are young, but when I boarded the old "Queen" some years ago, it seemed to be manned by Rip van Winkles, for the combined ages of its crew of four totalled up to about two hundred and fifty years! The Hoylake smacks trawl all over the eastern side of the Irish Sea, landing their fish at Bangor, Douglas or Liverpool, and stay away from port for comparatively long periods. Sometimes they fish in Carnarvon Bay, but not now in Cardigan Bay. They fish for whatever is in season, but their mainstay is Soles and Plaice; it is probable that but for the great appreciation in the value of the former fish during recent years, the Hoylake smack fishery would be a decadent one. The Soles are mainly caught in the summer and autumn in the sea offshore from the coasts of Lancashire and North Wales. Plaice are caught throughout most of the year, but are usually abundant in the Channel-course area, that is the sea between Point Lynas and the Liverpool North-West Lightship, where the fishery is an autumn and winter one. The vessels belonging to the smaller ports are all second class boats, locally known as "Nobbies," half-decked vessels, cutter-rigged, about ten tons in gross register, and about thirty-six feet in length; they carry trawls of about twenty-five feet in spread. They fish in shallow water fairly near the shore, in the estuaries, bays, and off the banks. They catch whatever fish are to be got, mostly "flukes," or they trawl for shrimps. Their crews consist of two men, or a man and a boy. The third class boats are open rowing boats, and are chiefly used in lining or in mussel fishing. There are no steam trawlers working from Cheshire ports.



A HOYLAKE TRAWLER.

At the beginning of 1909 the numbers of fishing boats and men in the county of Cheshire were as follows* :—

		Fishermen.
HOYLAKE—		
First class trawlers	39	156
Inshore trawlers	12	24
PARKGATE AND HESWALL—		
Inshore trawlers and open boats	36	72
TRANMERE, ROCK FERRY AND NEW FERRY—		
Inshore trawlers and open boats	22	44
NEW BRIGHTON—		
Inshore trawlers	4	6
EGREMONT—		
Inshore trawlers	4	6
Total	117	308

During the year ending 31st December, 1908, this fishing fleet landed in Cheshire :—

At Birkenhead, 3,854 tons of "wet fish" worth about £4,260.

At Hoylake, 1,692 tons of "wet fish" worth about £1,417.

These values, however, greatly underestimate the productivity of the Cheshire fisheries, for the Hoylake vessels, as we have seen, land a very considerable proportion of their catches at Bangor, Douglas and Liverpool.

The freshwater fisheries are mainly for Salmon and Trout ;

* I am indebted for these figures to Mr. H. Baines of the Fishery Office at Preston ; and to Captain G. Eccles, the Fishery Officer at New Brighton, for other information.

I refer to them in the sections relating to the natural history of those fishes. The freshwater fishery in the Dee is not of very great importance.

The sea fisheries off the coast of Cheshire are regulated by two authorities—the Dee Sea-Fisheries Committee, which has jurisdiction over the fisheries in the estuary landward of a line drawn from Hilbre Island to Air Point, and the Lancashire and Western Sea-Fisheries Joint Committee, with jurisdiction over the fisheries in the Mersey and without the coast of the Wirral Peninsula, and outside the line forming the seaward boundary of the Dee district. The freshwater fisheries are under the jurisdiction of the Dee Board of Conservators.

THE MARINE AND FRESHWATER FISHES.

GENERAL CHARACTERS.

Summarising very briefly the main facts outlined in the preceding pages, we see that the Cheshire sea area presents the following characters : it is a shallow-water area, the depth seldom exceeding sixty feet ; it is largely estuarine ; there are high and strong tides ; the temperature range of the sea water is relatively great, the salinity low and variable. Because of the set of the tidal streams, the prevalent winds, and the surface drift of the water due to the Gulf Stream, there is a general indraught of water into Liverpool Bay from the open Irish Sea and St. George's Channel in the south-west. The result of these physical conditions is that the marine fauna of the Cheshire sea area presents well marked peculiarities from a distributional point of view. On the other hand the fish fauna of the rivers, streams, lakes and ponds of the inland part of the county exhibits no very noteworthy features. The freshwater fishes of Cheshire resemble very closely those of any other of the west coast counties, with the exception of some

of the lakes in North Wales and Westmorland. The Mersey has practically ceased to be a Salmon stream, and the Dee, though it still contains this fish in some numbers, cannot be said to be as prolific as either the Conway to the south or the Lune to the north. Neither are there Trout streams of more than ordinary productivity; the Dee is in this respect inferior to the Ribble. The most noteworthy fact in relation to the freshwater fishes of the county is the acclimatisation of the Smelt in Rostherne Mere.

There are many features of interest in the distribution of the marine fishes. There are various types of fish fauna in the Irish Sea, characteristic of different areas. (1) The sea bottom off a rocky shore, shelving rapidly into deep water, and exhibiting the three zones of marine life, littoral, laminarian, and coralline. On such a shore there is not much variety in species and little abundance in individuals. (2) The sea bottom found off a sandy shore, sloping very gradually into deeper water, where little variety of fish life is found, but great abundance of individuals. (3) The deeper parts of the sea, well out from the shore, where the depth varies between thirty and fifty fathoms, and where the bottom deposits are sand or mud, or some combination of the two; there is great variety in the species found, but the area is not rich in individuals. (4) The offshore trawling grounds, varying in depth from about ten to twenty fathoms, and covering an extensive area; the fishes found here depend to some extent on the season, and the abundance of individuals is never so great as on the shallow-water grounds inshore.

The first type is exhibited by the sea bottom immediately round the south end of the Isle of Man; the second in greatest perfection by the inshore grounds of the Cheshire area; and the third in the sea offshore from the south of the Isle of Man. The fourth type of sea bottom—that which is the most favourable for fish trawling—includes practically all the sea bottom between the Isle of Man and the English coast.

Such a sea area as that found off the coast of Cheshire contains a greater abundance of life—that is, a greater absolute mass of organised substance—than is contained in any other part of the sea of equal area. The water above the bottom is rich in microscopic life, and may at times contain great numbers of pelagic fishes, such as the Sprat, Mackerel and Herring. The sea bottom, even when laid bare by the ebb tide is full of life; thus there are great quantities of cockles on the sands off the coasts of Lancashire and Cheshire, and here and there, where the sea bottom is harder, mussel-beds are formed. The sands are rich in other bivalve molluscs, such as *Mactra*, *Tellina* and *Scrobicularia*, in worms and small crustaceans. Where there are seaweeds, and even on the bare sands, where there is not much depth of water, there are incredible masses of diatoms. The worms, the smaller crustaceans, the smaller molluscs, such as *Hydrobia* (which is at times extremely abundant in the Dee), and other small bottom organisms afford food for hordes of crabs, shrimps and other crustaceans, which are in their turn the food of the fishes. The diatoms and other microscopic plants are eaten by the molluscs, which are again the food of many fishes.

The general characters of the local fish fauna can only properly be ascertained by numerous well planned trawling experiments. Shore collecting in such an area as Liverpool Bay conveys an entirely false notion of the wealth of its fish life. Line fishing, using different forms of bait, would reveal many species of fishes, but no adequate idea of their abundance could be obtained. But by the use of the trawl, employing different forms of mesh, representative samples of the bottom life of the sea can be obtained, and it is in this way that the Cheshire grounds have been explored. A typical haul with this apparatus, almost anywhere in the channels of Liverpool Bay or behind the banks, consists of a great mass of invertebrates, the most abundant of which are crabs (*Portunus*, *Carcinus*, *Stenorhynchus*, *Hyas*),

hermit crabs (*Pagurus*), and starfishes (*Asterias*). If the mesh of the net is small enough shrimps are generally taken in large numbers. Other invertebrates are also captured, and along with this mass of life a number of fishes belonging to comparatively few species. As a rule, Dabs are more abundant than any other form ; then would come Plaice and Solenettes. Flounders are not very numerous, unless well up the estuaries. Soles may be taken, but these fishes are never so numerous as either Plaice or Dabs, and they may not be represented during the colder months of the year. Sometimes the net catches enormous numbers of Sprats, these fishes being caught pelagically while the trawl is sweeping through the water on its way down to the sea bottom. During the autumn months great hauls of young Whiting may be made, and sometimes, instead of Whiting, Codling are taken. The net nearly always contains a few Skates or Rays, and perhaps a Gurnard or two.

These are all edible fishes, but a haul with a trawl net of small mesh always produces a number of other species. The most abundant of these are Weevers, Pogges and Dragonets. Sand Eels (*Ammodytes*) and Sucker Fishes (*Liparis*) are also taken, but not in abundance. Other inedible fishes are met with from time to time.

A typical catch made on the Cheshire grounds may be illustrated by quoting the results of three hauls witnessed by myself in July, 1908. The nets employed were a fish trawl of six-inch mesh, that is, each mesh measured an inch and a half from knot to knot, and a shrimp trawl which had a mesh measuring half an inch from knot to knot. These nets were " bent " on to the same trawl-beam, one of thirty feet in length. Three hauls were made, the trawl being dragged for about an hour on each occasion, and covering about nine miles of ground on all three drags. The hauls were made from the sailing cutter of the Lancashire and Western Sea-Fisheries Committee, stationed at NewBrighton. Two hauls were made in Hilbre Swash, and one in the

entrance to Horse Channel. The total catch of fish was as follows :—

Dabs	877
Plaice	442
Ray	84
Soles	16
Whiting	6
Grey Gurnards	5
Flounders	2
Codling	1
Total edible fishes ..	1,433

The other fishes in order of abundance were Weevers, Pogges, Dragonets and Gobies. No Herrings nor Sprats were taken on this occasion.

This was not a large catch, but may be regarded as illustrating the kinds of fishes which may be taken during the summer months. Sometimes enormous numbers of Dabs, Plaice, Whiting, Herrings, Sprats and Solenettes are taken on occasions which are in one way or another exceptional. Thus in September, 1893, a shrimp-net dragged for half an hour behind Burbo Bank caught—

Plaice	10,407
Dabs	375
Codling	69
Soles	12
Other species	169
Total	11,032

This was an unusually large catch of Plaice ; it is not often that so many are taken in one haul. As a general rule Dabs are the more plentiful. It appears that on this ground there is a complementary relation between the two species, Dabs being most abundant when Plaice are scarce,

and *vice versâ*. Sometimes hauls of over ten thousand Whiting have been made, and often as many Sprats are caught in one drag.

A fairly accurate notion of the nature and abundance of the dominant fish of Liverpool Bay may be obtained by considering average catches. Trawling experiments designed with this intention have been carried on since 1893 by the officers of the Lancashire and Western Sea-Fisheries Committee. I quote here some of the results already published* of experimental hauls made by means of a shrimp trawl having a beam of about twenty-five feet in length, and a net of half-inch mesh. Generally the trawl was dragged for about an hour over two miles of sea bottom, and the majority of the hauls were made behind the banks at the entrance to the estuaries of the Mersey and Dee. The numbers of fishes caught vary from month to month, there being periods of maximum and minimum abundance for each of the species. Considering only the four most abundant fishes we find that the average monthly catches for the period 1893–99 are as follows :—

Whiting ..	1,180 (August) to 30 (December).
Plaice	975 (September) to 75 (December).
Dabs	812 (August) to 168 (February).
Soles	99 (August) to 0 (December).

Other edible and inedible fishes were taken in smaller numbers. Including all the edible forms, the average monthly catch in September, the maximum month, was 2,631 fishes ; and the average in December, the minimum month, was 335.

These experiments show that there is, in the case of each of the species considered, a seasonal change of abundance, so that it is possible to predict roughly what kind of catch

* Johnstone and Jenkins, *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1900 (Liverpool, 1901), pp. 39–55. Also Wollaston, *op. cit.*, 1907 (1908), pp. 87–93.

may be expected at any time of the year. Of course, it often happens that altogether unexpected catches are made, for local or abnormal conditions may produce temporary scarcities or aggregations of fish on parts of the area. It is also impossible to control the fishing action of the trawl so that it will always work in an uniform manner; indeed different fishermen do not always use the apparatus in precisely the same way. The nature of the weather and the state of the tide affect the abundance of the catch; thus a spell of cold east winds appears often to produce a scarcity of fish in the inshore waters by driving them into deeper channels offshore, and unusually violent winds, which cause a heavy sea, have generally the same effect. Perhaps the fish "dawk," that is bury themselves in the sands, on such occasions; this appears to be a common habit among flat-fish. Soles, Whiting, Dabs and possibly some other fishes are often taken in greatest abundance during spring tides, and are scarce during spells of fine clear weather. The reason may be the calm water and less disturbed state of the sea during neap tides. When the water is clear and the transparency great, the fish may see the net and so elude capture. Anyone who has studied the behaviour of Soles and other flat-fish in an aquarium must have noticed how very alert they are. Rough weather and strong tidal streams stir up the soft bottom sediment and make the water turbid; then the fish do not see the net and are captured in greater numbers. This, at any rate, is the explanation that old experienced fishermen often give.

The vast majority of the fishes which inhabit the inshore water of Liverpool Bay are sexually immature; the grounds in question constitute a veritable "fish nursery." This is indeed the case with most of the grounds along the English coast from about Rhyl so far north as the Solway. Here and there the sea bottom slopes rather rapidly down into deeper water, and when this is the case the fish fauna resembles that of the offshore fishing grounds. The grounds

off the Mersey and Dee, the Ribble Estuary and Morecambe Bays are all such fish nurseries, but such an area is exhibited in greatest perfection by the sea bottom in the Cheshire area. As a rule, foreigners who visit this part of the British seas and witness hauls with a shrimp trawl are astonished at the abundance of young edible fishes. Practically all the Plaice caught are less than two years of age and are, of course, sexually immature. This is also the case with the Whiting, Herrings, Rays, Gurnards, Soles, and indeed most fishes, except at those rare periods when there are exceptional shoals of such mature fishes as Herrings or Haddocks, which come into inshore waters as the result of some unusual physical stimulus. Dabs, Solenettes and many of the smaller inedible species are mature fishes when found in Cheshire waters; so are Flounders, though they appear to go out into deeper water to spawn during a month or two in the spring. Large mature Plaice and other fishes are of course occasionally caught in quite shallow water; this is the case during autumn to a greater extent than at other seasons. Nevertheless, the characteristic fish population of the inshore part of Liverpool Bay is an immature one.

This condition has made the question of the regulation of the fisheries in the territorial waters off the coast of Cheshire an exceedingly complicated one, and has been productive of much discussion and trouble between the fishermen and the Fishery authority. Generally speaking the aim of the latter has been to discourage as much as possible the capture of small flat-fish of little marketable value; a policy which is expressed in regulations governing the dimensions of trawl-nets, and the sizes of the meshes which may be employed. At first sight it appears an obvious provision in the general interest of the fishing industry that the capture of such small fishes should be avoided, for then they might be allowed to become big ones. But one suspects the apparent simplicity of such an argument; it is perhaps possible that the preservation of

the small fish on such a crowded area as that of the Cheshire grounds might be compensated for by an increase in the amount of natural destruction.

GENERAL HABITS AND LIFE-HISTORIES.

The species of fishes which are recorded as having occurred in the marine and fresh waters of the county may be arranged in various categories according to their distribution and life-histories. These categories are :—

(1) *Indigenous species*, living for the whole period of their life-histories in Liverpool Bay, and reproducing there. The best examples are the Solenette, Weever, Goby, Pogge, Bullhead and Dragonet.

(2) *Migratory species*, inhabiting the inshore part of Liverpool Bay during the early part of their life-histories, but spawning in the deeper water outside the territorial limits or in St. George's Channel. Examples : Plaice, Sole, Cod, Whiting, Haddock, Ray, Turbot.

(3) *Migratory species*, visiting Liverpool Bay at periodic times to spawn, or as the result of some physical changes in the condition of the sea water. Examples : Bass, Herring, Mackerel, Grey Mullet.

(4) *Species found rarely or exceptionally* in Liverpool Bay. Examples : Sturgeon, Opah, Anchovy, Angler.

(5) *Anadromous species*, those which ascend the rivers in order to spawn, or descend the rivers to the sea for the purpose of spawning. These are the Salmon, Trout and Eel.

(6) *Freshwater species*, which live for the entire period of their lives in the rivers or ponds. Examples : Perch, Dace, Roach.

The indigenous species include a few which are relatively uncommon, such as *Gobius flavescens*, *Trigla pini*, *Callio-*

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nymus maculatus, *Ammodytes lanceolatus* and *A. tobianus*, and possibly some others. The Smelt, *Osmerus eperlanus* is naturalised in Rostherne Mere. The Gurnards and Dog-fishes are ubiquitous, though not relatively abundant. The Weever, Common Goby, Dab and Dragonet are the most abundant species belonging to this category.

The migratory fishes which inhabit Cheshire waters during the juvenescent stages are those which are really characteristic of the area. All the species of *Pleuronectidae*, except the Dab and Solenette, belong to this category. The Dab is present during the entire period of its life-history. The Plaice, Sole and the others occur only during their earlier phases, as is the case also with the gadoid species.

The other migratory species do not visit Liverpool Bay particularly for the purpose of spawning. Bass, Herring, Mullet, Mackerel, Sprats and Shads do not appear to spawn in the inshore waters off the coasts of Cheshire. Their eggs are to be found there (with the exception of those of the Herring and some others), but this is no proof that they spawn in our area, for the eggs may be transported into Liverpool Bay. It is the seasonal change in the temperature and salinity of the sea which appears to be the stimulus producing these migratory movements, or perhaps the change in the nature of the plankton.

Many of the fishes which I record as rare or exceptional have been seen very seldom indeed in the Cheshire area ; some on only one occasion. Examples of these are the Greater Weever, Sword Fish, Opah, Red Band Fish, the Forkbeard and Sting Ray. They are species which must be regarded as foreign to Liverpool Bay, and when they appear, are to be considered as stragglers. In the case of many others the sea off Cheshire appears to be the extreme southern or northern limit of their distribution, so that their occurrence, though normal, is not to be regarded as a constant character of the species.

SYSTEMATIC POSITION.

The living species of fishes may be grouped into nine orders, twenty sub-orders, and one hundred and ninety families. Of these, four orders, thirteen sub-orders and thirty families are represented in the fauna of the inland waters of Cheshire and in the sea immediately adjacent to the coast of the county. At the present time there are about twelve thousand well established species of fishes recorded from the marine and fresh waters of the Earth, and at least one hundred and seven of these occur in our area.

One-third of the species belong to four families. Other four families have four species each; three have three; nine have two; and eighteen families are represented by only one species each. The fauna is therefore a fairly representative one, but because the area is one which presents very uniform physical conditions the majority of the recorded species belong to few families. If it were possible to make a "census," it would probably be found that at least seventy-five per cent. of the fishes present in the Cheshire waters at any one time would belong to at the most half a dozen genera and only two families. The fauna is a representative one, but there is a great predominance of forms belonging to very few groups.

The *Gadidae* and *Pleuronectidae* are by far the most abundant families, and most of the fishes commonly taken are species of these subdivisions. Most of the British *Pleuronectidae* are represented, the exceptions are such species as have their normal habitats at the extreme north or south of the British sea area. Thus the Halibut, a northern fish, is not known to occur, and the Sand Sole, *Solea lascaris*, Risso, is also absent. The Halibut occurs in the Clyde, and the Sand Sole in the inshore waters of Cardigan Bay. Liverpool Bay therefore just lies between the limits of distribution of these species. The Whiff *Lepidorhombus whiff* (Walbeyer), is recorded, but I doubt

if it occurs. The One-spotted Topknot, *Zeugopterus unimaculatus* (Risso), is very rare.

The *Gadidae* are very abundant, but here again there are some notable exceptions. Couch's Whiting, *Gadus poutassou* (Risso), has not been found, and probably does not occur. The Four-bearded Rockling, *Onos cimbrius* (Linné), is not recorded, but I think this fish may turn up some time as the result of a lucky find. Both of these species are known from the Clyde. The Norway Pout, *Gadus esmarkii*, Nilsson, is so far unrecorded, but I have found this fish in the inshore waters of Morecambe Bay. It is easily mistaken for the ordinary Whiting, and I have no doubt that minute examination of the enormous numbers of young specimens of the Whiting which are often taken in the shrimp trawls would reveal the Norway Pout. This too is a northern fish, and Cheshire would appear to be just beyond its southern limit of distribution. The only British freshwater gadoid, the Burbot, *Lota lota* (Linné), is said to have been taken from the Weaver*, but I have been unable to procure a specimen, and I doubt very much whether it now occurs. The common Cheshire gadoid is the Whiting, which with the Haddock is present at times in enormous numbers.

Probably the *Clupeidae* is the next most abundant group of fishes. The Sprat and Herring are the most common species but all other clupeids are rare. The Anchovy is a southern form which wanders so far north as Liverpool Bay but not into the Clyde. The only Shad said to occur is the Twaite, *Clupea finta*, Cuvier; the Allis Shad, *Clupea alosa*, Linné, is not recorded. Nevertheless the latter species is found in the Menai Straits. It is not easy exactly to distinguish between the two species, which are very closely allied; I think it is probable that the Allis Shad may be occasionally present.

The *Cyprinidae* are very well represented in the Cheshire rivers and ponds, where they appear to be more abundant,

* Byerley, p. 30.

both in species and individuals, than in the Cumberland and Clyde areas. The Bleak is recorded from Cheshire waters, but it has been impossible during recent years to procure a specimen of this fish, and I do not feel justified in recording it as a member of the present fauna. The *Salmonidae* are represented by only four species, which is less than are found in the adjacent areas to the north and south. I follow recent opinion in including the Sea Trout and Brook Trout in one species, *Salmo trutta*, Linné. There are both Sea Trout and Brook Trout in the county, but the former variety does not appear to distinguish itself by assuming those puzzling forms which are to be encountered in the rivers of North Wales and elsewhere. The Smelt and Argentine, the other two salmonoids represented, are both very uncommon in the sea, but the Smelt occurs in an acclimatised condition.

The *Trachinidae*, *Gobiidae*, *Agonidae*, *Triglidae*, *Cottidae*, *Anguillidae* and *Gasterosteidae* come next in order of abundance, their relative frequency of occurrence and absolute abundance being roughly (so far as one can judge without actual statistical enumeration) that of the above list. A scorpaenid fish, *Sebastes norvegicus* (Müller), is recorded by Byerley, and appears also to have been taken to the north-west of the Cheshire area. I think it is doubtful whether this fish was really taken in local waters. Several other species of *Gobiidae* are recorded, but there is some confusion in the synonomy of this genus, and I mention only species with regard to the occurrence of which there is no doubt. Many fishes which we regard as shore-loving forms, haunting stony and weedy ground, are very scarce. The *Labridae*, for instance, are just represented. Byerley recorded captures of the Gilt Head, *Crenilabrus melops* (Linné), and the Gold Sinny, *Labrus rupestris* (Linné), as far back as 1850 and 1854, but it is the rarest occurrence for either of these fishes to be found now. I have often taken both species as well as *Labrus mixtus*, Linné, offshore from the Cheshire area proper, but it was only at the

beginning of the present year that I have been able to obtain a specimen of the Gold Sinny, and prefer to omit the Gilt Head until the record is confirmed.

The Red Mullet, *Mullus barbatus*, Linné, is not recorded, but this fish certainly occurs on the near shores of Anglesey, and almost certainly visits Cheshire waters occasionally. The Shanny, *Blennius pholis*, Linné, has not been found, but the fish occurs in the Menai Straits, round the shores of the Isle of Man, in Barrow Channel and in Morecambe Bay. It is almost certain that it is to be found in Cheshire waters, though up till now I have not been able to get a specimen. The Sea Bream, *Sparus centrodontus*, De la Roche, is not recorded, but I am sure that it might be taken on lines set on suitable parts of the coast. The Tommy Noddy, *Raniceps raninus* (Linné), and the Broad-nosed Pipe Fish *Siphonostoma typhle* (Linné), are also forms which are not included in the list of species but which may confidently be expected to turn up when further examination of the rougher ground in the Cheshire area is made.

It ought to be remembered that the apparent richness or poverty of the fauna of a sea area may be traced to the resources at the disposal of the collectors. Thus there is an apparent poverty of the fishes characteristic of rocky shores on the coast of Cheshire. On a suitable collecting ground, such as that of the south end of the Isle of Man or in many parts of the Firth of Clyde, shore collecting is easy, therefore the fishes inhabiting the rock pools and weedy sea bottoms in those localities are fairly well known; almost exhaustive lists have been prepared. But there is comparatively little such shore on the coast of Cheshire, and the result is that many fishes which we are accustomed to look for on a rocky coast are apparently absent, or are difficult to find. But there is sea bottom of just this character in the Cheshire sea area, though it is unfortunately unexposed by the tides, and is therefore difficult to examine, for it is impossible to use a trawl on some of this ground, as

for instance on the sea bottom in the Rock Channel opposite to the Wallasey mussel-beds. It is unfortunate, from the point of view of the naturalist, that prawning for *Pandalus* is now abandoned on the grounds off Air Point, for prawn trawling, because of the rough ground on which it is practised, is a very valuable means of obtaining marine specimens. It is the case then that we know the sandy part of the sea bottom adjacent to the Cheshire coast very well, probably better than any other part of the sea bottom off the west coast, but there are other parts of the area which are not nearly so well investigated. Caution is therefore necessary in speaking about the apparent absence of some species. On the other hand the evidence with regard to the distribution of those forms which inhabit sandy ground is very complete because of the extensive observations which have been carried out. It is practically certain, for instance, that the Sand Sole is really absent from Liverpool Bay, but it is not nearly so certain that such fishes as the Shanny, or the Broad-nosed Pipe Fish are absent. Reservations of this nature, with reference to the facilities for practising all the methods of the collector in an area, are not, it seems to me, often enough made in discussions of the distribution of marine species in different areas.

The scheme of classification of fishes adopted in the following pages is that of Mr. G. A. Boulenger of the British Museum.* There is now general agreement among ichthyologists as to the classification of the fishes other than Teleosts; but since the latter form a very compact and homogeneous group there is some room for difference of opinion as to the arrangement of the genera. The absence of any authoritative general work on the fishes is a disadvantage to the worker on the taxonomy of these animals. Günther's *Catalogue* was such a work, but the investigations of the last thirty years have added so many new forms that the scheme of classification adopted by Günther is now no longer tenable. The new *British Museum Catalogue of*

* *See* "Fishes and Ascidians," *Cambridge Natural History*, Vol. VII., 1904.

Fishes will, of course, supply the defect, but unfortunately only one volume of that work is as yet published. Boulenger's classification of the *Teleostei* seems on the whole the best expression of the relationships of the genera. But it may be pointed out that he and Mr. C. Tate Regan regard the characters of the skeleton as the best criteria of the phylogeny of the families and genera, a conclusion to which morphologists may reasonably take exception, for the study of the soft parts of the structure of fishes certainly seems to be too important in this respect to be neglected. There is also some difficulty with regard to the best generic names to be employed, and I have thought it best, with certain reservations, to adopt the names of the fishes as given in the *Scandinavian Fishes*.

PISCES.

TELEOSTOMI.

TELEOSTEI. *MOLIDAE.*

Sub-order *PLECTOGNATHI.*

SUNFISH. *Orthagoriscus mola* (Linné).

Only once recorded from local waters.

The Sunfish has been once recorded from Liverpool Bay ; a fine specimen was captured in 1864 by some Southport fishermen, and the skeleton was obtained for the Liverpool Museum.* The length of this fish was three feet six inches, and its depth, including fins, four feet nine inches. The body was twenty-two inches deep, the dorsal fin eighteen inches, and the anal fin seventeen inches.

LOPHIIDAE.

Sub-order *PEDICULATI.*

ANGLER. *Lophius piscatorius*, Linné.

Local name—Devil Fish.

A deep-water fish not infrequently visiting Cheshire waters.

The Angler is not an abundant fish in Liverpool Bay, being a species characteristically inhabiting deep water offshore.

*T. J. Moore, *Liverpool Lit. and Phil. Soc. Proc.*, Vol. XIX., 1866, p. 11.

It grows to a great length (six to seven feet), but no example so large as this has been found in local waters. The largest Angler recorded appears to be one noticed in Rhos Weir, Colwyn Bay, by Mr. J. D. Siddall in June, 1901*; it was four feet six inches in total length, and when caught had a brass tray of twelve inches diameter in its mouth, so tightly wedged in that it could not be removed. On May 28th, 1852, W. Fell of Warrington† found one stranded on a sandbank in the Mersey near Warrington. It had made desperate efforts to escape into the receding tide, so that the skin of its tail was almost worn away by attrition against the sand. T. J. Moore mentions an Angler which was stranded at Tranmere during the gale in which the *Royal Charter* was wrecked, and records the capture of three other large specimens.‡ It is not infrequently stranded on Hilbre Island; and I have often caught it in the trawl-net in the sea offshore from Cheshire. One found by Mr. L. N. Brooke on November 10th, 1907, stranded on the shore at Flint, weighed over thirty pounds.

The Angler is a voracious fish. Its mouth is very large, and the curved, sharp-pointed teeth are hinged so that they can be bent backwards. An animal caught by the fish easily slips into the mouth, but if it attempts to withdraw itself the teeth start up erect, held in that position by ligaments, and are driven into its flesh. Even to put one's hand into the mouth of a dead Angler invites injury. When caught in a trawl-net it proceeds to gorge itself with the other fishes in the same plight, and when the net is hauled the fishermen usually gut all Anglers caught so as to rescue for the market any Soles or Plaice that have been swallowed. It is a rather repulsive looking fish, but is now a marketable product, being sold locally under various names. The head is cut off, and the tail portion is either filletted or

* Herdman and Dawson, p. 36.

† *Zoologist*, 1852, p. 3600.

‡ *Liverpool Lit. and Phil. Soc. Proc.*, Vol. XIX., 1866, p. 11.

WINSFORD BOTTOM FLASH.

cut into slices and sold as "cod steaks"; the flesh is good and the deception a harmless one.

Perhaps owing to its omnivorous habits, the Angler is usually the host of a number of parasites. I have hardly ever seen a local specimen which did not contain the peculiar myxosporidian, *Glugea lophii*, Doflein, either encysted on the trunks of the cranial nerves, or in the ridiculously small brain of the fish. The remarkable copepod *Chondrocanthus lophii* (Johnstone) occurs adherent to the gills; and the leech *Trachelobdella lophii*, van Beneden and Hesse, occupies a similar position, or may be present on other parts of the skin. The distomid *Gasterostomum gracilescens* (Rudolphi) is found in the alimentary canal; local specimens are often very largely infested with this worm.

The Angler lays pelagic eggs, and these are enveloped in a sheet of mucus which floats on the surface of the sea. It spawns offshore in deep water, but curiously enough the eggs have not so far been found in Liverpool Bay.

PERCIDAE

Sub-order *ACANTHOPTERYGII.*

PERCH. *Perca fluviatilis*, Linné.

Widely distributed and abundant in the fresh waters of the county.

The Perch is one of the most widely distributed and abundant of Cheshire freshwater fishes; it is found throughout the county in rivers, canals, meres, marl-pits and ponds. Locally, it spawns in March, April and May. The life-history of the Perch in Cheshire waters does not present any peculiarities. Pennell* mentions the capture of

* "Fishing," *Badminton Library*, Vol. II., p. 252.

deformed specimens at New Brighton, but the Perch, by reason of long continued domestication or restriction of distribution, is prone to malformations or deformities. It does not appear, locally at least, to be subject to epidemic disease, such as may occur among Roach or salmonoid fishes in rivers or ponds.

RUFFE. *Acerina cernua* (Linné).

Local name—Daddy Ruffe.

A freshwater fish of local occurrence in Cheshire.

The Ruffe is only of local occurrence in Cheshire. Byerley records it from the Dee above Chester. It has been taken at Pickmere,* from the river Dane, from the Peak Forest canal near Marple, and near Chester and Middlewich. Some anglers consider, although of course erroneously, that the Ruffe is a cross between the Perch and Gudgeon, or the Perch and Tench.

SERRANIDAE.

BASS. *Roccus labrax* (Linné).

Local name—Sea Perch.

Common in inshore waters in spring and summer ; migrating into Liverpool Bay, but not spawning there.

The Bass is a southern fish, reaching Liverpool Bay with the inflowing warm water of the summer. It goes so far north

* De Tabley, *MS. note-book.*

as Morecambe Bay, but does not appear to occur in the Clyde. It is one of the most distinctively migratory fishes of the west coast of England and Wales, where it appears about the beginning of June, to disappear again about the end of September. I have often taken it in the offshore waters of Liverpool Bay, and it occurs fairly commonly in the estuaries of the Dee and Mersey, though not so abundantly as in the Conway Estuary and Morecambe Bay. It leaves these inshore waters at an earlier date than it does the open sea well off the coasts. Its migration along our shores appears to be determined by some physical change in the condition of the water, most probably the rising temperature in the early summer. It does not appear to spawn in local waters ; at least, I can find no record of its eggs or larvae.

The Bass is an economic fish in local waters, and generally commands a ready market, selling at 4d. to 6d. per pound. It is held in some estimation as a food fish on the west coast of England and Wales, probably on account of its Salmon-like appearance, for its flesh is rather dry. It is usually caught on lines, baited in various ways, in stake-nets and trammels, and with the trawl. In local waters it feeds, as a rule, upon Sand Eels. It is hardly ever abundant enough to be an important fisherman's fish, but it has great interest for the sea angler. In Liverpool Bay, North Wales and Morecambe Bay it usually attains the weight of from four to six pounds, but elsewhere it grows to a much greater size.

The Bass harbours several parasites which are not usually found in other local fishes, an indication that the greater part of its life-history is passed outside our area. These are—the copepod, *Lernanthropus kröyeri*, van Beneden and Hesse ; the distomid worms, *Allocreadium labracis* (Dujardin), and *Echinostomum imbutiforme*, Molin ; and the gephyrean, *Echinorhynchus proteus*, Westrumb. The external trematodes, *Microcotyle labracis*, van Beneden and Hesse, and *Diplectanum aequans*, Diesing, also occur.

CEPOLIDAE.

RED BAND FISH. *Cepola rubescens*, Linné.

Once recorded.

A Red Band Fish about sixteen inches in length, now in the Liverpool Museum, was taken alive at Seacombe on March 29th, 1862.* It can only be considered as an accidental straggler to the area.

SCIAENIDAE.

MAIGRE. *Sciaena aquila* (Lacépède).

Recorded only once from Liverpool Bay.

The Maigre or Shade Fish does not belong to the local fauna. The only record which I have been able to obtain is that of one which was captured in October, 1870, in the Queen's Channel. The specimen is now in the Liverpool Museum.

LABRIDAE.

GOLD SINNY. *Labrus rupestris* (Linné).

Rare in local waters.

Byerley recorded a capture of this fish from Hoylake in 1850, but until quite recently this was the only known local occurrence of the Gold Sinny. In February, 1907, however, Captain Eccles, Fishery Officer at New Brighton, who had never seen the fish before, brought me an example

* T. J. Moore, *Liv. Lit. and Phil. Soc. Proc.*, Vol. XVI., 1862, p. 154.

which had been taken in the trawl-net in the Rock Channel. The species is undoubtedly rare in our area, and probably occurs only on the few patches of rough bottom, as, for instance, in the neighbourhood of the Wallasey mussel-bed, or about Air Point.

SCOMBRIDAE.

MACKEREL. *Scomber scombrus*, Linné.

A migratory fish, visiting Liverpool Bay in summer and spawning there.

The Mackerel is one of the migratory fishes which visit Liverpool Bay in the summer and depart again in the autumn. It is a "south fish," and its migrations on our coasts are associated with the movements of water due to the Gulf Stream drift. It does not inhabit the Atlantic water proper, but rather the mixture of this with the sea water diluted by the fresh water from the land. The Mackerel shoals which visit Liverpool Bay appear first on the Irish side of the Channel near the Old Head of Kinsale, and migrate further to the north as the season advances. They generally appear in Liverpool Bay about the beginning of June, but the date of the first occurrence varies to some extent from year to year.

Mackerel are fairly abundant in Liverpool Bay during the summer months, and form the material of a fishery of some local importance. They are usually caught by means of lines and hooks baited with some bright shining object. Sometimes a bit of bright metal, such as a piece of tin from a tobacco box, is used, but so soon as a fish has been caught the hooks are baited with pieces of Mackerel skin; this is the usual bait locally. Why the fish should strike at an object of this kind is rather puzzling, for its food in local waters always consists of copepods or other small pelagic

crustacea. Mackerel are caught off the Formby shore in stake-nets, which are constructed with meshes of smaller dimensions than usual. Drift netting for this fish is not practised in local waters to any great extent.

The Mackerel is a pelagic fish, that is it inhabits the upper layers of the sea. When it is caught, as often happens, with the trawl-net, it is taken as the trawl is descending to the bottom in the process of being "shot" and is towed through the sea meanwhile. It spawns in Liverpool Bay and generally over the greater part of the Irish Sea and Channels. The eggs are pelagic, and have been taken in the tow-nets in Cardigan Bay in June and July, in Liverpool Bay in June, and off Port Erin in the Isle of Man in August. Probably there are no defined spawning grounds, the fish simply parting with its eggs as the reproductive organs mature.

Mackerel in local waters contain the parasites *Anchorella scomberi*, Basset Smith, and *Anchorella paradoxa*, van Beneden, both copepods. A distomid, *Distomum gulosum*, Linton, has also been found, a form apparently identical with a worm described from fish occurring in North American waters.

XIPHIIDAE.

SWORD FISH. *Xiphias gladius*, Linné.

A straggler to the Irish Sea ; once recorded from Cheshire waters.

The Sword Fish, which has been taken in the Bristol Channel and off the Irish coast but is rare in British seas, has once been captured in the estuary of the Dee. Pennant, who calls it the "Sicilian Sword Fish," says : "One was taken in *October* 1785, in the new cut for the *Dee* above *Flint*, nearly at the same time with the Beaked Whale."*

* *British Zoology*, 1812, iii., p. 217.

PLEURONECTIDAE.

TURBOT. *Bothus maximus* (Willughby).

Rare in local waters.

The Turbot is certainly rare in the sea off the estuaries of the Dee and Mersey ; large and mature Turbots only occur very occasionally in shallow water. Young and immature fishes are sometimes taken in the shrimp trawls dragged off the Mersey Banks, but even small Turbot do not often visit this area. The fish seems to be one which inhabits deep water at almost all stages of its life-history. The Turbot spawns in the sea well offshore, and its eggs, which are pelagic, have been found in the plankton of the territorial waters of Liverpool Bay during the month of June.

BRILL. *Bothus rhombus* (Rondel).

Local name—Brett.

Common in the young stages in local waters.

The Brill is far more common in local waters than the Turbot, but large examples seldom occur. It is a species which characteristically inhabits the deeper water offshore ; but the young stages come into the shallow water far oftener than do those of the Turbot. Brill are frequently taken off the entrances of the channels by the larger sailing trawlers, but never in great abundance. The fish spawns in the summer in the deeper water offshore, and the eggs, which are pelagic, have been found in the plankton collected from the territorial waters of Liverpool Bay during June.

MÜLLER'S TOPKNOT. *Zeugopterus punctatus* (Bloch).

Not uncommon in local waters.

Müller's Topknot occurs not infrequently in the shrimp trawls working off the Mersey and Dee Banks. This pretty little fish is by far the most abundant of the topknots, and is probably more abundant in our area than the catches made by the shrimp trawls indicate. It is fairly common in the catches made by the prawners in other parts of the territorial waters off the west coast, and if it were possible to use this method of fishing in local waters to a greater extent than is at present the case, our knowledge of the distribution of the fish would, no doubt, be extended. Not many are taken in the shrimp trawls, and fishermen have no common name for it—usually calling it "a kind of fluke." It is a pelagic spawner, and probably reproduces in local waters, but its life-history there has not been specially investigated. It is small, and therefore of no economic importance.

BLOCH'S TOPKNOT.

Zeugopterus unimaculatus (Risso).

Rare in local waters.

Bloch's Topknot is rare in the inshore waters of Liverpool Bay, though taken not infrequently in the open sea offshore. So far the only local record which I have is that of a specimen captured by the Liverpool hopper "Beta," trawling for the Liverpool Museum off the Mersey Banks in 1902.

NORWEGIAN TOPKNOT.

Scophthalmus norvegicus (Günther).

Very rare in local waters.

The Norwegian Topknot is the rarest of its kind in local waters. It has only been taken on two or three occasions in the Irish Sea, and the fish itself does not, apparently, occur in the territorial waters of Liverpool Bay. It is therefore rather curious that the eggs, which are pelagic, have been identified from inshore waters in Liverpool Bay by Mr. A. Scott. The fish spawns in July, in which month the ova were obtained from the plankton.

WHIFF. *Lepidorhombus whiff* (Walbeyer).

Local name—Megrim.

Very rare in Liverpool Bay.

The Whiff is a deep-water species which occurs only very exceptionally in shallow water. It is one of those fishes which are taken frequently, but not abundantly, in the deep water to the south of the Isle of Man ; examples found in our area are stragglers from this habitat. I have never seen it in the catches of the shrimp trawls in local waters, but one captured in 1775 on the coast of Flintshire is recorded by Pennant,* and Byerley states that he had specimens from the Dee in 1851 and 1853. It does not spawn in Liverpool Bay ; its eggs have not, so far, been found in the territorial waters off the west coast.

* *British Zoology*, 1812, iii., p. 324.

SCALD FISH. *Platophrys laterna* (Walbeyer).

Local name—MEGRIM.

Occasionally found in Liverpool Bay.

The Scald Fish or Megrim occurs now and then in the shallow waters off the estuaries of the Dee and Mersey, but it is never abundant. I have seen so many as half a dozen examples from a single catch made by a shrimp trawl. Byerley recorded its capture at the mouth of the Dee in 1852. Probably the Scald Fish spawns offshore, and the pelagic eggs, drifting towards the west coast, develop on the shallow water nursery grounds, where the young fishes are associated with other immature pleuronectids. It appears to be more common in the neighbourhood of the Mersey and Dee than off the Ribble or in Morecambe Bay. The Scald Fish is occasionally seen in the fish shops, but, locally, it is a species of no economic importance.

PLAICE. *Pleuronectes platessa*, Linné.

Local names—FLUKE ; PLAICE FLUKE.

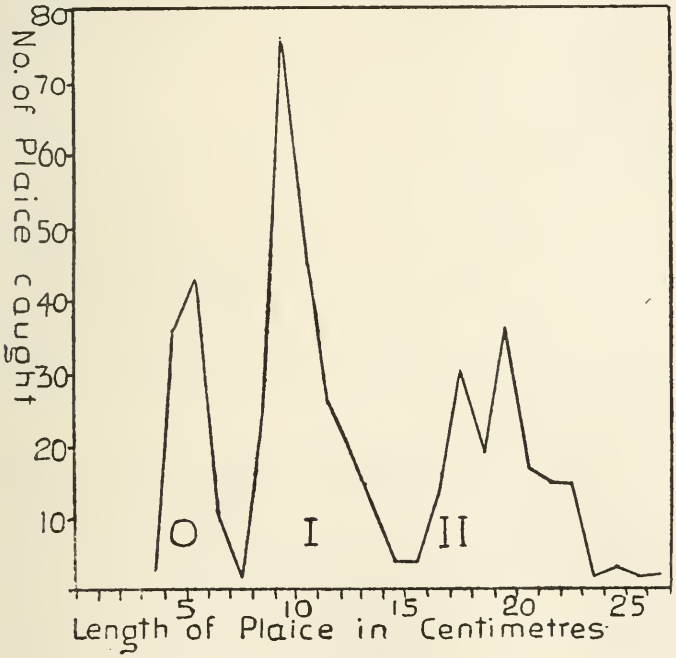
Very abundant in Cheshire waters.

The Plaice is one of the most characteristic fishes of local waters. It is abundant and widely distributed throughout the sea within the twenty-fathom contour line ; outside this limit it is not nearly so common. The density of the Plaice varies roughly with the depth of water ; the deeper the water the scarcer is the fish. In shallow water the characteristic Plaice are small ones. The fish is a migratory one, but its wanderings depend on the change of habit which is induced as the fish becomes older and upon its

THE MERSEY ESTUARY FROM THE WALLASEY SANDHILLS.

season of spawning. Changes, seasonal or otherwise, in the temperature of the sea cause migrations of the fish, while minor migrations are occasioned in the search for suitable feeding grounds.

The vast majority of the Plaice found within the territorial waters of Liverpool Bay are immature. Occasionally during the autumn large and mature Plaice are captured in quite



Graphic representation of the sizes of Plaice caught in several hauls off the Dee and Mersey.

shallow water, but the number of these compared with that of immature fish is insignificant. I give here a chart which illustrates the composition of a series of catches made in the neighbourhood of the estuaries of the Mersey and Dee.

The numbers along the horizontal axis are the length (in centimetres) of the Plaice caught; those on the axis

represent the numbers of fishes caught. The curve is a "tri-modal" one, that is, there are three principal groups of fish. Group O. contains Plaice having a characteristic length of five centimetres; all these are under one year old. Group I. contains fish which have a characteristic length of ten centimetres; this group is mixed, containing many fish which are less than twelve months old, but the majority are over one and less than two years of age. Group II. is also mixed; most of the fish are over two and less than three years of age, but some belong to Group I. and a few to Group III., which are over three and less than four years old. Groups III., IV., and V., which are present in the offshore waters of the Irish Sea, are sparsely represented in the shallow inshore area of Liverpool Bay. The characteristic lengths are not the average sizes, but those at which the majority of the fish are to be found. Most of the Plaice inhabiting the Cheshire sea area belong to Group O. The average sizes in the Cheshire area are:—at one year old, seven and a half centimetres; at about eighteen months, nineteen centimetres, and at about two years and a half, twenty-two centimetres.

The Plaice does not spawn within the territorial waters of Liverpool Bay. The principal breeding areas lie outside the twenty-fathom line to the north-west, between the coasts of Lancashire and Cumberland and the Isle of Man, as well as to the south-west, in St. George's Channel. The female reproduces when it attains a length of about fifteen inches, and the male when it is about eleven inches long. These are average lengths; the length of the Plaice on the assumption of sexual maturity varies considerably. It is very probable that the average length at first sexual maturity of Plaice inhabiting the inshore waters of Liverpool Bay is decreasing, a change which is doubtless due to the action of natural selection, for the greatly increased intensity of fishing during the last half century has induced a general decrease in the average size of fish inhabiting our inshore waters. Therefore it is an advantage to the species

if the individuals reproduce at an earlier phase of their life-history, and such an advantageous variation will doubtless be inherited. A large mature female Plaice spawns annually about 300,000 eggs, not at one time but in batches. Spawning occurs during the months of February to April, with a maximum in March, and the eggs occur in the plankton of Liverpool Bay during those months. The eggs are pelagic and the larvae hatch out in from fourteen to twenty-four days, according to the temperature of the sea. Plaice eggs spawned to the north-west of Liverpool Bay probably do not supply the nursery grounds in this area, since the set of the tidal streams and surface drift of water is in the opposite direction. I think that the young fish which inhabit the Cheshire sea area have developed from eggs spawned to the south-west in the open waters of St. George's Channel, for the direction of the drift of water is from south to north. Certain conditions—a relatively high temperature, a flat sandy bottom, abundance of suitable food and moderate salinity of the water—are necessary for the further development of the little fish ; these conditions are afforded by the physical features of the Cheshire area. If the larvae happen to drift into the relatively fresh water of the estuaries they probably perish, since they may sink to the sea bottom.

The larva is at first pelagic. It is small and resembles closely the pelagic larvae of many other teleost fishes. About a month after hatching, the metamorphosis of the larva into the form characteristic of the species takes place. The body of the little fish becomes flattened dorso-ventrally, and at the same time a rotation of the head occurs which causes the eyes to be situated on the same side of the body. Plaice larvae have assumed this phase in Liverpool Bay at the end of May, or the beginning of June at the latest.

About this time great numbers of small Plaice and other flat-fishes are to be found all along the coasts of Cheshire where the water is clean, not too fresh, and where the sea bottom consists of fine clean sand. They may be found,

for instance, on the sands to the west of New Brighton landing stage in the little shallow pools, not too high up the beach, left by the receding tide. They are alert and agile, and feed on copepods and small shellfish, such as the very young stages of cockles and periwinkles. During the early summer enormous numbers must perish, being left by the tide in shallow sand pools from which the water subsequently drains away or evaporates.

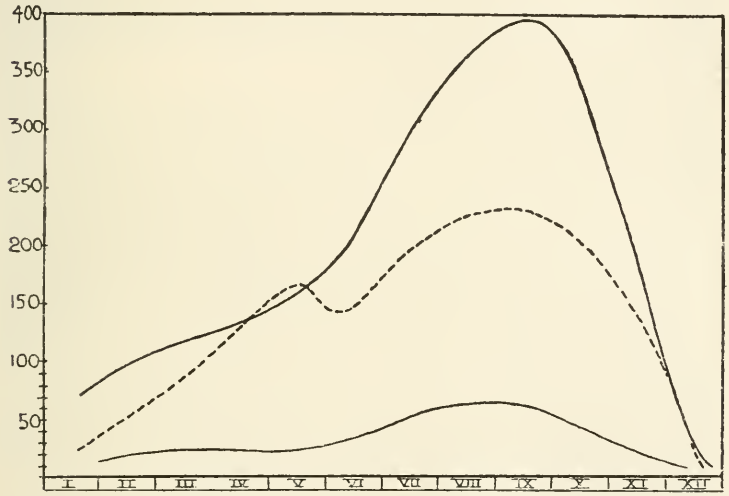
About the middle or end of June, according to the season, these little Plaice disappear from the Wallasey shore, but from this time onwards enormous numbers of slightly larger fish are caught in the shrimp trawls in the channels and on the margins of the banks just off the estuaries of the Dee and Mersey. The characteristic size about the end of June is four centimetres. The fish grow very quickly and by the end of October the majority are about seven and half centimetres in length. From November till about the end of March the Liverpool Bay Plaice, both at this and subsequent stages, cease to grow, do not migrate extensively, nor do they feed greedily. During the months of December and January they probably exist in a state of semi-hibernation, usually buried in the sand. The average weight of locally caught Plaice steadily decreases during the months of December to February, rising again later. This decrease in the average weight of the fish is to be associated with the cessation of feeding during the colder months of the year.

Plaice of all sizes are most abundant in local waters during August and September—the summer of the Cheshire sea area—and least abundant during December to March. This is indicated in the chart on page 75, which represents the seasonal abundance of Plaice on the Mersey and Dee shrimping grounds, as expressed in the number of fish caught per hour's trawling during the period 1892–1905.*

This is the evidence afforded by a statistical examination of the catches of fish made during the trawling experiments

* H. J. Buchanan Wollaston, *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1907, pp. 87–93.

of the Lancashire and Western Sea-Fisheries Committee. It does not necessarily mean that there are fewer Plaice in the Cheshire sea area in December than in August, but merely that fewer are caught by the shrimp trawls. The fish *is* less abundant during the period of minimum catches because enormous numbers must be destroyed by the inshore trawlers fishing for shrimps; but the minimum numbers caught are also due to the habit adopted by the Plaice



Seasonal abundance of various Fishes in the sea off the Dee and Mersey. The thick continuous line represents the variation from month to month of Plaice caught in the shrimp trawl; the dotted line indicates the monthly variation of Plaice caught in the six-inch mesh fish trawl; and the thin line, the variation in numbers of small Soles caught in the shrimp trawl. The numbers on the vertical axis represent the numbers of fish caught per hour's trawling. The Roman numbers on the horizontal axis are the months. (From *Lancashire Sea-Fish. Laby. Report* for 1907, p. 87, and Plate V.)

during cold weather of burrowing in the sand, so that it is not easily captured in the trawls.

When the Plaice has resided in local waters for about the first three years of its life it migrates offshore. The reproductive organs now mature, and the fish spawns for the first

time during its fourth or fifth years. The intensity of fishing in the Irish Sea is now so great that only a small proportion of the Plaice spawned survive to reproduce once, and still fewer to reproduce a second time. Having spawned in the deep water about the twenty-fathom line the Plaice may occasionally return to shallow waters. This migration takes place in the late summer or autumn, when fairly large fish are taken just outside the entrance to the channels, or even in the stake-nets set along the shores. If it should visit the shallow waters, the fish always migrates offshore again when the temperature of the sea is beginning to fall to its annual minimum.

The migrations of the Plaice in local waters—apart from those referred to above—are conditioned by changes in the temperature of the sea, by unusually rough weather, or by changes in the abundance of food. These minor migrations have been studied by making "marking experiments"; that is, fish of eight to ten inches in length are marked by the attachment of a numbered brass label, and are as speedily as possible liberated. These experiments are advertised and rewards paid to the fishermen who return any marked fish they may catch. About two thousand Plaice have now been marked and liberated at various parts of the sea along the coasts of Lancashire, Cheshire and North Wales, and nearly one-fourth of these have been recaught. To some extent this percentage of recaptures is an index of the "intensity" of the Plaice fishery in local waters. It is hardly justifiable to say that because twenty-five per cent. of the marked fishes liberated have been recaptured, twenty-five per cent. of *all* the Plaice in the same area have been caught by the fishermen—though this inference has been made; but it is evident that a large proportion of the Plaice inhabiting the sea bottom in the inshore waters of Liverpool Bay must be taken. When Plaice of the sizes mentioned are liberated in the autumn and early winter, the migrations are alongshore ones. The fish simply moves along the shallow water from place to place, and is usually

caught by the shore-fishing methods—stake-netting, inshore trawling, trammels, and "tees"—in the shallow bays and estuaries, chiefly in the Dee, Mersey, Ribble, Menai Straits or Holyhead Harbour. As a rule, the winter migrations are feeding ones, but the fish may move about in response to changes in the temperature of the water. When the fish are liberated in the spring or summer similar migrations are observed, but towards the end of the summer, Plaice of a certain size begin to move to the deeper water offshore. There is a very profitable local fishery off the coast from near the Nelson Buoy in the estuary of the Ribble to Red Wharf Bay in Anglesey; the fish taken there are those which have migrated in the early summer from the estuaries and bays on the Lancashire and Cheshire coasts. When this fishery ceases, the Plaice, or at least those that have survived, begin to migrate into the deeper parts of the Irish Sea; many Plaice, marked and liberated off the coasts of Lancashire and Cheshire, have been recaptured off the east and south coasts of Ireland. This migration is the spawning one.*

Exceptional abundance of food always sets up a local and temporary migration in Liverpool Bay Plaice. This was the case, for instance, in August and September of 1908 in the inshore Cheshire waters. There was an exceptional abundance of small cockles and "sand-pipes" (*Pectinaria*) and large numbers of small Plaice congregated to feed on this ground.

The food varies with the phase of the life-history. At first the pelagic larvae feed on the planktonic organisms—probably diatoms or other protista—though very few observations have been made on this point. Plaice of one-half to one inch in length when caught on the Wallasey shore are almost always found to be feeding on copepods, which the little fish finds in the sand at the sea bottom. I have

* For full details of these marking experiments see Johnstone, "Rept. on Experiments with Marked Fishes, &c.," *Lancashire Sea-Fish. Laby. Ann. Repts.* for 1905–09.

counted from fifty to one hundred examples of these micro-crustaceans in the alimentary canal of a single fish not much over three-quarters of an inch in length. Sometimes the stomachs of these fishes contain a trematode—probably *Appendicularia*—which may be taken from the copepods. Other favourite foods are very small periwinkles or other small gasteropods, or young cockles. As the fish grows older it abandons crustaceans as food and devours sand-living worms or molluscs. The polychaete worm *Pectinaria* is a very common food in local waters. The molluscs are nearly always the lamellibranchs *Mactra*, *Scrobicularia*, *Tellina*, and less commonly, *Solen*. The species *Tellina balthica*, Linné, is a very common food—it is known to the fishermen as "hen-pens," or "hen-fish." If a bed of young mussels or cockles is formed the Plaice feeds greedily on these animals. When it becomes older and moves offshore, the razor-shell (*Solen*) becomes the most common food.

The Plaice is *the* fisherman's fish in local waters. Dabs are perhaps more abundant but they are very lightly esteemed, and the staple fishery is for the "Plaice Fluke." Small fish, as are the majority of those caught in local waters, do not bring a high price ; perhaps twopence to threepence a pound may be regarded as the average when the Plaice is plentiful. It is, however, so generally abundant that a good deal of reliance is placed upon it.

The Plaice is singularly free from parasites ; I have seen the following species only very exceptionally—the copepods *Chondrocanthus cornutus* (Müller) on the gills ; *Lepeoptherius pectoralis* (Müller) on the gills and skin under the fins ; the cyclops stage of *Lernea branchialis*, Linné, on the gill filaments ; and *Bomolochus soleae*, Claus, in the nasal chambers. An unidentified appendiculate trematode is found in small Plaice from the Wallasey shore. A myxosporidian, *Glugea stephani* (Hagenmüller) is found very exceptionally in the wall of the intestine ; whilst another protozoon belonging to the same group, *Sphaerospora*

platessa, Woodcock, is sometimes obtained from the cartilage of the cranium.

Malformations rarely occur in local Plaice. I have seen one or two specimens with pieces bitten out from the body or tail, possibly by dog fishes. The fish easily recovers from such injuries. "Reversed" examples must be exceedingly rare. I have examined several thousands of local Plaice in such a way that a sinistral specimen could not possibly have been overlooked, but have never yet met with one.

FLOUNDER. *Pleuronectes flesus*, Linné.

Local names—WHITE FLUKE; MUD FLUKE.

Indigenous and fairly abundant in Liverpool Bay.

The Flounder is not nearly so abundant in local waters as the Plaice, and its distribution is rather different. It is far more plentiful in the upper reaches of the estuaries than the Plaice, but it does not occur in such abundance in the open sea. It appears to prefer water of low salinity, and can even live where the water is quite fresh. It is said to frequent the mouth of sewer outfalls—probably on account of the low salinity—and has received contemptuous names on account of this habit. It is very abundant in the upper parts of the estuaries—at Garston in the Mersey, for instance, and is caught even so high up the Dee as Farndon. It is taken in the fish and shrimp trawls employed off the mouths of the estuaries, but I have seldom seen more than half a dozen examples taken in one drag. The fish is more commonly taken by means of "tees," stake-nets and trammels. Sometimes it and the Plaice are caught by "spearing"—a technically illegal method of fishing. It is not esteemed as a food fish in Cheshire or Lancashire. The Flounder spawns in the spring, and its eggs, which are

pelagic, are found in the territorial waters off the coast in February, and in the sea offshore from February to April. The fish appears to be one which is acquiring an anadromous habit, since it descends the estuaries in January and goes out to sea to spawn. Probably it spawns fairly near the shore; after the reproductive act it returns to the upper parts of the estuaries, and for the rest of the year inhabits waters which may be brackish. The larvae hatch out from the egg in from five to fourteen days, according to the temperature. Although the species is closely related to the Plaice, its life-history is strikingly different. The mature female is much more prolific, the incubatory period of the egg is much shorter, and the larva differs greatly from that of the Plaice. The larvae are pelagic and have much the same habits as those of the larval Plaice; among the small pleuronectids which may be taken on the Wallasey shore in the early summer there is a considerable proportion of Flounders. Unlike the Plaice, the Flounder becomes mature in the shallow waters near the shore, only going out into the open sea in order to spawn.

The Flounder when in the sea feeds on much the same organisms as the Plaice, molluscs and worms. It is far more subject to malformations and abnormalities than the Plaice, and reversed (sinistral) specimens are not uncommon in local waters. Bicoloration, that is, the more or less complete pigmentation of the normally colourless side, is also fairly common. Often this bicoloration is accompanied by an incomplete metamorphosis of the larva; the translocation of the left eye may be delayed until after the growth forward of the dorsal fin has taken place; the fin then forms a little hook arching over the imperfectly shifted eye.*

Circular wounds of the skin about half-an-inch in diameter produced by the bites of Lampreys are sometimes present. Certain parasites are very common in local Flounders.

* Johnstone, *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1905, pp. 186–191, Fig. 25.

THE RIVER DEE, FARNDON BRIDGE.

The copepod *Lepeophtheirus pectoralis*, Linné, is by far the most abundant. These parasites, called "fish lice" by the fishermen, may inhabit any part of the skin, but usually crowd together underneath the pectoral fins. A distomid which is very common in the intestine may possibly belong to the genus *Allocreadium*. Flounders taken from the Dee and Mersey are often the hosts of a very singular parasite, first specially characterised from local waters—the sporozoon *Lymphocystis johnstonei*, Woodcock. Fish infected with it are known locally as "scabby flukes." The parasite forms white or grey tumours, which may be present on any part of the body. The tumours resemble raspberries, and are at times so big as marbles, giving the fish a peculiarly repulsive appearance.

DAB. *Pleuronectes limanda*, Linné.

Local names—GARVE; FLUKE.

Indigenous and very abundant in Liverpool Bay.

The Dab is the most abundant food fish in local waters. It is ubiquitous, inhabiting water of any depth in the Cheshire district, and occurring at all times of the year. It does not ascend the rivers to the same height as the Flounder, but is sometimes found in quite brackish waters. There is no regularity in its distribution with regard to the depth of water. Its abundance in local waters is often complementary to that of the Plaice, the Dab being abundant when the Plaice is scarce, and *vice versâ*. The Dab is caught locally by trawl-nets, shrimp-nets, stake-nets, trammels (in the Dee) and "tees." It is not nearly so valuable a food fish as the Plaice, but is preferred by some people. Locally, its flesh is rather soft, and the fish does not keep well; it is, however, palatable.

The Dab spawns in Liverpool Bay in the spring; its pelagic eggs are abundant in the plankton from March to May. The fish becomes mature when about five inches long, and spawns fairly close inshore; I have known great numbers of spawning Dabs to be caught near the Liverpool Bar. The life-history is rather similar to that of the Plaice, the larvae being pelagic and the very young metamorphosed individuals being found in enormous numbers on the Wallasey shore along with the Plaice and Flounder. Later in the year the young fishes, from one inch in length, are taken abundantly by the shrimp trawls. Sometimes many thousands are caught in one drag; the average number per haul taken by Captain Eccles during the period of the experimental trawling was 1,196. The period of maximum abundance in local waters is in September. The seasonal variation in abundance is much the same as that of the Plaice, but the fish is more evenly distributed throughout the year, and there is not the same falling-off in the numbers caught as winter approaches, in fact north from Liverpool Bay the Dab is most abundant in the winter and spring months.

The Dab is an omnivorous feeder, and representatives of almost all groups of marine organisms (except algae) have been found in its stomach. Locally, the most common food animals of the Dab are sand stars (ophiurids), small crabs (chiefly *Portunus* and hermit crabs), and lamellibranch molluscs such as are eaten by the Plaice; other animals, such as Sprats, polychaete worms, actinians and zoophytes are eaten, and the foot of the spiny cockle (*Cardium echinatum*, Linné) is a common food. The fish must bite off the part of the foot of the mollusc which protrudes from between the valves of the shell, and do this smartly, for the mollusc can contract and close its shell very rapidly. It is because of its catholic tastes that the Dab is more abundant and generally distributed in local waters than the Plaice—the food of which is rather restricted.

Local Dabs harbour few parasites. I have only seen

the distomid worm, *Stephanochasmus baccatus*, Nicoll. The larval stage of this parasite inhabits the flesh of the fish just underneath the skin, and is easily visible to the naked eye as a small opaque spot. Sometimes these distomids are so numerous as to give the fish the appearance of "measly" pork; in such cases the Dab is greatly emaciated.

WITCH. *Pleuronectes cynoglossus*, Linné.

Rare in local waters.

The Witch is the least abundant member of the genus *Pleuronectes* in strictly Cheshire waters. It inhabits the deeper parts of the Irish Sea, and only occasionally comes on to the inshore fishing grounds. Mature Witches may sometimes visit the shallower parts of Liverpool Bay, but I have never seen them in the catches made by the shrimp trawls, though young and immature examples are sometimes taken. The fish is an offshore spawner, and the eggs, which are pelagic, drift to the Lancashire and Cheshire coasts. Witches may often be seen in local fish shops, where they are sold as "White Soles," "Yarmouth Soles," or simply "Soles," but these fish are caught outside the territorial waters by the larger trawlers, or perhaps outside the Irish Sea by the steam trawlers.

LEMON SOLE. *Pleuronectes microcephalus*, Donovan.

Local name—Sweet Fluke.

Rare in local waters.

The Lemon Sole is found just outside the territorial waters in much greater abundance than inside those limits. It is taken by the trawlers in the Channel Course—the track

of the vessels approaching Liverpool from Point Lynas—or in the sea at the entrance to the Horse Channel. Even on these fishing grounds it is much less abundant than the Plaice, Dab or Flounder. Young immature Lemon Soles are, however, taken in the shrimp trawls worked outside the estuaries, but are never very numerous. The Lemon Sole, though esteemed as an article of food, is not abundant enough to be of much importance to the local fishermen.

The only parasite recorded from the Lemon Sole in local waters is the copepod *Chondrocanthus clavatus*, Bassett-Smith, which is found on the gills.

LONG ROUGH DAB.

Drepanopsetta platessoides (Fabricius).

Local name—Ganny Fluke.

Rare in local waters.

I know of no previously published record of the occurrence of the Long Rough Dab in Liverpool Bay, for though Byerley mentions it he merely says : "Rare near the shore, more frequent in deep water." Early in December, 1908, Captain Eccles sent me an example of this fish which had been taken in the Rock Channel. This fish was remarkable in being entirely devoid of pigment ; even the black lining almost invariably present on the peritoneum was absent, and the fish was so transparent that the viscera could be plainly seen through the skin. The Long Rough Dab is not uncommon in the sea about the north end of the Isle of Man, whither it appears to repair in order to spawn ; examples taken there are usually full of eggs, and are generally caught in the early spring. It is a northern fish, inhabiting the North Sea in fair numbers, and Liverpool Bay appears to be the extreme southern limit of its range.

SOLE. *Solea solea* (Linné).

Fairly abundant in local waters.

The Sole is generally distributed over the Irish Sea, and is found almost everywhere in the sea just beyond the territorial waters. Outside the twenty-fathom line it is not so abundant. It exhibits well marked seasonal migrations, moving into shallow waters during the spring and summer months, migrating out again in the late autumn as the temperature falls. During the colder months it probably buries itself in the sand on the sea bottom near the twenty-fathom contour-line. It may be fairly abundant in quite shallow waters during the warmer months, but from October to April it is rare within the territorial limits.

The Sole spawns offshore during the months May to July. The eggs are pelagic, and are commonly taken in the sea offshore, but it is singular that they have not, so far, been recognised in the plankton collected within the territorial waters of Liverpool Bay. Yet the larvae must drift towards the Lancashire and Cheshire coasts, for the young immature stages of the Sole are sometimes very abundant in quite shallow waters off the estuaries. The largest catch recorded is one made by Captain Eccles in the Rock Channel in November, 1898, when six hundred and twenty-eight young Soles were taken in two drags of a shrimp trawl. I give a curve representing the seasonal variations in abundance of Soles in the Cheshire shallow-water area (*see* p. 75). The thin line represents the seasonal variations of young Soles, for the most part less than one year old, taken in the shrimp trawls.*

The Sole fishery of the Irish Sea is of considerable importance; the capture of this fish constitutes the mainstay of the fine fleet of Hoylake smacks which at the present time work in Liverpool Bay and the eastern part of the Irish Sea. It is probable that many of these vessels would have been laid up long ago but for the lucrative nature of the summer

* Wollaston, *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1907, pp. 87–93.

and autumn Irish Sea Sole fishery, especially during the last ten years, when the price of this fish has increased. I have a record of a week's fishing (Monday to Friday inclusive) of one Hoylake smack, during which time nine hundred and sixty-nine pounds of Soles were taken. The local Sole fishery has been almost as productive of legislation as that for the Salmon. When the Lancashire Sea-Fisheries Committee was constituted in 1899, the fishermen employed trawl-nets of four-inch mesh, and one of the first regulations made by the Committee raised this size to seven inches. But it was found that while a seven-inch mesh was very suitable for Plaice fishing, it allowed a fairly large number of quite marketable Soles to escape. The Hoylake fishermen then began an agitation for the repeal of this bye-law, which lasted almost without intermission until the beginning of 1908. For some years they had been allowed to use a six-inch trawl mesh in certain parts of the territorial waters and at certain times of the year, but since the beginning of 1908 the use of the smaller mesh has been permitted in all parts of the district.

Soles caught locally are nearly always the hosts of a trematode parasite, *Phylonella soleae*, van Beneden and Hesse, which inhabits the skin of the white side. Sometimes the leech *Platybdella soleae* (van Beneden and Hesse) is so abundant that the skin of the fish appears to be covered with thick brown hairs. The copepod *Bomolochus soleae*, Claus, is found in the nasal cavities of locally caught Soles. *Chrondrocanthus soleae*, Kröyer, a highly modified copepod, also occurs ; it is found attached to the gills.

SOLENETTE. *Solea lutea* (Risso).

Indigenous and abundant in local waters.

The Solenette is one of the most abundant of indigenous Cheshire fishes. It is a distinctively shallow water form

which is not found in numbers outside territorial waters. It is generally distributed along the Lancashire and Cheshire coasts wherever shrimping is carried on; it is I think more abundant in the shallow waters off the estuaries of the Dee and Mersey than in other parts of the Lancashire shallow-water area. It is usually mistaken for the young Sole, even by many fishermen, and indeed may easily be confused with that fish by anyone who does not pay particular attention to the finer distinctions between the two species. It is brown in colour, coarse in the scales, thicker than a Sole of the same length, and the black tip of the pectoral fin is not so deeply pigmented. This last character is the most useful one in the discrimination of the two species.

The Solenette is a small fish, never exceeding about five inches in length. It spawns in local waters in May and June; the eggs are pelagic and are found in the plankton in the territorial waters. It has no economic value, except perhaps that it may serve as the food of other fishes, such as the Cod and Ray.

THICKBACK. *Solea variegata* (Donovan).

Local name—Lucky Sole.

Rare in local waters.

The Thickback occurs frequently in the sea outside the territorial waters, where it is taken by the larger trawlers. It is rare in the catches made by the half-decked trawling vessels working immediately off the mouths of the estuaries, and I have never seen a specimen which was certainly taken in the inshore waters. Herdman and Dawson, however, record it as occurring at the mouth of the Dee.

GOBIIDAE.

ONE-SPOTTED GOBY. *Gobius minutus*, Pallas.

Local name—JACK SHARP.

Indigenous and abundant locally, especially in shallow waters.

The Common or One-spotted Goby is a widely distributed and abundant fish in local waters. It is generally present in the shallower parts of the sea outside the estuaries, and more abundantly still on the flats in the Dee and Mersey. There are two fairly well marked varieties, one of which, the estuarine form,* is apparently the fish described by Day as *Gobius parnelli*.† Specimens from the Dee have the following characters :—Fin formula—

D. VI., $\frac{1}{9-10}$; A. 1–9, and scale formula—L, l. about 38.

The formula given by Day for the typical *G. minutus* is

D. VI., $\frac{1}{10-11}$; A., $\frac{1}{10-12}$; L, l., 60–70.

Specimens from Hilbre Island and examples taken in the trawl-nets on the banks outside the Mersey have the same characters, except that there are forty scales in the longitudinal row. Indeed most of our inshore fish appear to be referable to the estuarine form. The Common Goby is sometimes taken in great numbers on this ground, where it is probably even more abundant than the captures by the shrimp trawls indicate, for even the half-inch mesh employed in that apparatus must allow large numbers to escape.

* *See* Holt and Byrne, *Ann. Rept. Sea and Inland Fisheries of Ireland. Scientific Invests*, 1901, Pt. 2, Appdx. No. 3, 1903; also *op. cit.*, 1902–3, Pt. 2, Appdx. No. 5, 1905.

† Day, *British Fishes*, I., p. 167.

The Gobies lay demersal eggs, usually on the internal surfaces of empty shells. Mr. A. O. Walker* gives an interesting account of the parental habits of this little fish. The Goby, "which is common in the estuary of the Dee, lays its eggs inside of the shell of any large bivalve mollusc, such as the common mussel (*Mytilus edulis*) or clam (*Mya arenaria*). It then (or possibly before) half buries the shell in the sand, the ova being in the unburied half, which may be seen sticking up at the bottom of shallow pools at low water, the Goby lying with its body under the shell and its head looking out. My friend, Mr. Allan B. Dick (to whom I am indebted for the fact), observing this, turned the shell up, whereupon a number of shrimps at once 'went for' the eggs, which were now exposed to view; the Goby drove them away, and then set to work, by digging with its head under one end of the shell, to replace it in its former position, which after some time and labour it succeeded in doing, when it resumed its place like a sentinel in his box."

TWO-SPOTTED GOBY.

Gobius flavescens, Fabricius.

Local names—Jack Sharp or Lady Hen.

Indigenous in local waters but not nearly so abundant as the last species.

The distribution of this species is very similar to that of the Common Goby, but it is not nearly so abundant anywhere in the Cheshire area. It exhibits similar habits with regard to the care of the eggs.

* *Chester Soc. Nat. Science, etc., Proc.*, Pt. IV., 1894, pp. 207–8.

ROCK GOBY. *Gobius niger*, Linné.

Local name—JACK SHARP.

Indigenous, but only common on rocky ground as at Hilbre.

The Rock Goby is by far the largest British *Gobius*. It prefers pools on a rocky sea bottom or beach as a habitat, and is not therefore often observed in Cheshire waters. It has been taken by Byerley and others on the shore at Hilbre Island, and I have seen it, but only exceptionally, in the catches made by the shrimp trawls working off the Mersey Banks. It is the rarest of the gobies which are known with certainty to occur in our area.

TRANSPARENT GOBY. *Aphya minuta* (Risso).

Indigenous and common in shallow water.

The Transparent Goby is a sand-loving fish which is abundant in the shallower waters of the Dee Estuary and in the sea off the banks in the bay. It shows a preference for shallow warm waters, and haunts the little channels and gutters among the banks. It may be caught in great quantities by using fine nets—say of coarse canvas—and mooring these in the narrower channels while the tide is running out. It is often taken in numbers in the shrimp-nets, but its size enables it to pass easily through the meshes of the trawl nets unless a great amount of weed or other *débris* has also been picked up. It is very transparent and is not easily seen among the catch, but it nearly always occurs among the small fishes—mostly Herrings and Sprats—which are sold as "Whitebait." The Transparent Goby is one of the most abundant of Cheshire indigenous fishes. Not much is known about its life-history in local waters.

COTTIDAE.

RIVER BULLHEAD. *Cottus gobio*, Linné.

Local name—MILLER'S THUMB.*

A freshwater fish, common in stony streams.

The River Bullhead is common throughout the county in clear streams and watercourses. Coward and Oldham record the case of a Little Grebe having been choked by a Bullhead which it had tried to swallow.†

SHORT-SPINED BULLHEAD. *Cottus scorpius*, Linné.

Local names—BULLHEAD; FATHER-LASHER; STING FISH; HARDHEAD.

Indigenous in shallow water in Liverpool Bay.

Two members of the genus *Cottus* occur in the shallow waters off the Cheshire coast. They appear to be rather less abundant here than in the deeper water outside the banks. The *Cottidae* are fishes which prefer rough, stony or weedy ground, and this kind of bottom is not easy to explore in Cheshire waters, so that the fishes in question may really be more abundant than they appear to be. They are commonly caught by the prawners working to the north of our district, and no doubt occur on the rough bottoms in the Rock Channel and at Air Point. As a rule the Bullheads found in the shallow waters of Liverpool Bay are small, only about four inches in length. The only spawning *Cottus scorpius* I have taken was caught in the trawl-net offshore from

* "Miller's Thumb" is really a generic term which is applied locally to several short stumpy fishes.

† *ante*, Vol. I., p. 454.

the Cheshire coast, and was about ten inches long. The fish is one of those which appear to attain greatest dimensions in cold water in the north ; thus, the variety of *C. scorpius* called *groenlandicus*, Cuvier and Valenciennes, is said to grow to a large size.

The *Cottidae* are demersal spawners, that is, their eggs are specifically heavier than sea water, and remain at the sea bottom when extruded. They are covered with adhesive mucus when liberated by the parent, and therefore adhere to whatever object they come in contact with when spawned. They are usually found in small masses attached to stones and seaweeds. These eggs are sometimes mistaken for Herring spawn, which is deposited in a somewhat similar manner.*

LONG-SPINED BULLHEAD. *Cottus bubalis*, Euphrasén.

Local names—BULLHEAD ; FATHER-LASHER ; STING FISH ; HARDHEAD.

Indigenous in Liverpool Bay.

The Long-spined Bullhead has been taken by Mr. A. O. Walker from the Dee,† and by Byerley from the north coast of Wirral. I think it is generally distributed in the shallow water of the Cheshire area where the bottom is hard. The examples taken in the shrimp trawls have, of course, strayed from the harder sea bottoms. It is not always easy to distinguish between this and the last species, but apparently *C. bubalis* is the less abundant of the two.

Fishermen have no constant names for these two fishes, and they are often called vaguely "Sting Fishes," a name, however, more generally applied to the Weever. The bull-

* *See* Ehrenbaum, *Wissenschaftliche Meeresuntersuchungen, Kiel Komm.*, Abth. Helgoland, Bd. 6, Heft 1, Kiel und Helgoland, 1904, for exquisite photographs of this and other demersal fish eggs

† Herdman and Dawson, p. 34.

heads are indeed not poisonous, and the wounds inflicted by their opercular spines are only troublesome when septic matter is incidentally introduced.

Cottus scorpius spawns in the spring, at which time its eggs are often taken by the prawners. *Cottus bubalis* is said to spawn in the spring, but the difference between the eggs of these two closely allied species is so slight that it is difficult to fix with certainty the spawning times.

CYCLOPTERIDAE.

LUMPSUCKER. *Cyclopterus lumpus*, Linné.

Local names—Sea Hen; Sea Owl; Cock Paddle.*

Indigenous in local waters but not abundant..

The Lumpsucker occurs in Cheshire waters, but it is never abundant. It is often taken in the trawl and stake-nets, or is stranded in rock pools or on the beach. It does not appear to be a familiar fish to seaside visitors. There are numerous local records—Bootle, Hoylake, Garston and Tranmere—and no doubt the fish is generally distributed. W. Fell of Warrington† records the capture of a Lumpsucker so far up the Mersey as Garston; this fish, an exceptionally large specimen, was one foot nine inches in length. I have often seen immature examples, from an inch upwards in length, taken in the shrimp trawls.

The Lumpsucker spawns in local waters from the end of February to the beginning of May. The eggs are demersal, and are laid on the shore, where they are often exposed at low water during spring tides. The fish emits all the eggs

* Byerley, p. 31. I am unable to verify the local use of this name. "Cock Paidle," as the name of a fish, occurs in Scott's *Antiquary*.

† *Field*, XIX., 1862, p. 323.

contained in the ovaries about the same time, that is, the spawning act is not prolonged over a fairly long interval as in the case of some fishes. When deposited the eggs are covered with a syrupy fluid, a secretion of the ovaries, which hardens on contact with sea water, causing the eggs to adhere. The ova laid by one fish form a mass about the size of a man's head, and weigh perhaps two or three pounds. When freshly laid the eggs are of a beautiful pink colour, but as development proceeds they become darker, owing to the formation of pigment in the larvae. The egg-mass is irregular in shape, with concavities and sometimes actual perforations. Some fishermen imagine that these eggs are those of the Salmon ; no doubt because of their colour.

When the eggs are spawned, the female leaves them and takes no care for their safety, but when an egg-mass is found on the shore, the male parent fish is generally "standing by." He attends to the eggs so carefully that he is often left by the tide in some shallow rock pool, where he is at the mercy of any predatory bird or small boy. Before the actual laying of the eggs there is probably a nuptial fight between two or more males attending upon the spawning female, which ends in one of the males driving away the female and the other males, and assuming the guardianship of the eggs. The hatching of the eggs may take many weeks, but throughout this period the male refuses food, driving away from the ova any other fishes that may approach. The egg-mass is very compact, and if it were simply left on the sea bottom the eggs in the interior would not receive enough oxygen, owing to the deficient circulation of water through the mass. The fish, therefore, takes water into his mouth and blows it out again over the eggs, the ordinary action of the opercula being reversed for this purpose. These reversed respiratory movements have been observed to take place at the rate of sixteen times every ten seconds. Sometimes the fish produces the water current by waving his tail, or other fin, to and fro in front of the eggs. The concavities and perforations in the

egg-mass are made by the parent fish for the purpose of facilitating the respiratory currents.

Although usually a dull and sluggish fish, the male Lumpsucker becomes alert and pugnacious when in charge of the eggs, and he will drive away or fight with intruders; if kept in a tank with the eggs he will make violent charges at the glass front if anyone approaches. When the larvae begin to hatch out he deserts the eggs and begins to feed, his parental duties then being at an end.*

SEA SNAIL. *Cyclogaster liparis* (Linné).

Local names—SUCKER; TOAD FISH.

Indigenous, but not very abundant.

The Sea Snail, though an indigenous fish in the shallow waters off the Cheshire coast, is never abundant. It is, however, often present in the catches made with the shrimp trawls working in the channels off the mouths of the Dee and Mersey. It has been taken so far up the Mersey as between Garston and Dingle.

MONTAGU'S SUCKER.

Cyclogaster montagui (Donovan).

Local names—SUCKER; TOAD FISH.

Indigenous but not abundant in local waters.

The habitat and distribution of Montagu's Sucker is practically the same as that of the preceding species. It is not, however, so abundant in Cheshire waters.

* An excellent account of the parental habits of the Lumpsucker is given by Fulton in *Fishery Board for Scotland, Ann. Rept.* for 1905, Pt. 3, pp. 169–178.

AGONIDAE.

POGGE. *Agonus cataphractus* (Linné).

Local names—MILLER'S THUMB ; ARMED BULLHEAD.

Indigenous and abundant in local waters.

The Pogge is one of the most abundant of the indigenous Cheshire fishes. It is common in the sea off the estuaries at all times of the year, and forms a usual and sometimes dominant part of the catch of inedible fishes made by shrimp trawls. It spawns in local waters, and probably passes through all stages of its life-history there. It is seldom seen in the catches made in the deeper water outside our area.

TRIGLIDAE.

GREY GURNARD. *Trigla gurnardus*, Linné.

Local names—GURNET ; KNOWD.

Indigenous in Cheshire waters, but most abundant in the early immature stages.

The Grey Gurnard is one of the most ubiquitous of Irish Sea fishes, and there are few places where a haul with a trawl-net fails to procure one or more of these creatures. It is common at all seasons of the year, and gives no indication of phasical abundance such as would result from well marked periodic migrations. Mature specimens may be caught on the shallow-water Cheshire fishing grounds, but the larger Gurnards appear to prefer the deeper water offshore. The inshore part of Liverpool Bay is a " nursery " for this as well as many other fishes.

The Grey Gurnard spawns in the early summer—in

April or May—in the territorial waters off the west coast of England. The pelagic eggs have a large oil globule within the yolk. Unfortunately this character is common to all the local members of the genus, and there is therefore some doubt as to which species any egg obtained in the plankton may belong. *Trigla gurnardus* is, however, the most abundant of the three local forms, and probably the majority of the fish eggs identified as those of the gurnard belong to this species.

YELLOW GURNARD. *Trigla lucerna*, Linné.

Local name—GURNET.*

Indigenous, but more common in offshore than inshore waters.

The Yellow Gurnard is not nearly so abundant as the last-mentioned species. It has much the same distribution, but the young immature forms do not appear to frequent the inshore shallow waters to the same extent as the young of the Grey Gurnard. The mature fish is much more abundant on the fishing grounds offshore than in the shallow-water area.

RED GURNARD. *Trigla pini*, Bloch.

Local names—GURNET ; SOLDIER.

Rather rare in inshore Cheshire waters.

The Red Gurnard has much the same habitat and distribution as the other local *Triglidae*. It is difficult, in my opinion, to say whether or not it is more abundant than *T. lucerna* ; Byerley, in 1854, came to the conclusion that

* Herdman and Dawson (p. 35) give "Tub" as a local name, but I have never heard local fishermen use it, though it is employed on the east coast.

the Red Gurnard was the rarest of the three Liverpool Bay species, and this seems to be the case at the present day.

Gurnards in Liverpool Bay are usually the hosts of the trematode parasites *Placunella pini*, van Beneden and Hesse, and *Phyllocotyle gurnardi*, van Beneden and Hesse. It is rather remarkable that they are almost always infested, sometimes to a quite notable extent, by the plerocercoid larva of the tapeworm *Tetrarhynchus erinaceus*, van Beneden. This worm inhabits the peritoneal cavity of the fish, being attached to the wall of the intestine, enclosed in a little double-walled cyst. The mature worm is never found in the gurnard, but infests various species of rays and dog fishes. Probably the gurnard becomes infected by devouring some crustacean which has eaten the proglottides which have been expelled *per anum* by the adult host of the cestode.

All the gurnards possess sharp-pointed spines on the bones of the opercula, and in handling and gutting the fishes the hands of fishermen are often lacerated; wounds are produced which suppurate and are sometimes very painful. The men say that the fish produces poison, which is injected when the wound is made, but I think it is certain that the septic contamination of the puncture is the cause of the subsequent sore.

TRACHINIDAE.

LESSER WEEVER.

Trachinus vipera, Cuvier and Valenciennes.

Local names—Stinger; Sting Fish; Weever.

Indigenous and exceedingly abundant in Cheshire waters.

The Lesser Weever is one of the really abundant fishes of the Cheshire sea area. I have rarely seen a catch from

a shrimp-net which did not contain from a few up to several hundreds of this fish. It is indigenous to the shallow-water area, and passes through its entire life-history there. It seems always to be associated with abundance of shrimps; probably the physical conditions suitable to the crustacean also suit it. It appears to be more abundant in the sea off the mouths of the Dee and Mersey than in either the Ribble or Morecambe Bay areas.

Fishermen have a very sincere dread of this fish, which is one of the very few anywhere in the seas of the world that produces a real animal toxin. When they see any Weevers in the catch made with a shrimp-net they never attempt to sort with their hands, but use a piece of wood for this purpose; for the same reason shrimping is never carried on in the dark. Nevertheless, in spite of all precautions, there are few local fishermen who have not suffered from the sting of the Weever.

The fish is a very pretty little creature; it is plump and fat, and is eaten occasionally. It has a bright silvery skin, but the first dorsal fin is deep black in colour, giving the fish a somewhat sinister appearance. This dorsal fin has five strong spines which are nearly always erect; if the Weever is caught by the tail it will often try to turn round so as to bring the spines into contact with the hand of the person holding it. A larger spine which is borne by the operculum lies alongside the head. Each of these spines, dorsal and opercular, is grooved, the grooves on the opercular spine being dorsal and ventral and those on the fin being lateral. A transverse section of a dorsal spine is T-shaped, the base of the T being anterior. Along these grooves and at the bases of the spines there are poison glands, masses of gland cells without ducts or follicles. The integument covers the gland cells and all but a portion of the point of the spine.

The fish inflicts its wound by striking either accidentally or intentionally, and is said to direct its poison spines at an enemy with skill and precision. Usually it buries itself in the sand, leaving the tip of the dorsal fin

protruding. The Sole is supposed to gain protection by mimicking the Weever ; it is said to bury itself in a similar way in the sand, leaving only the deep black pectoral fin exposed. When the fish stings, the point of either of the spines—the opercular one is said to be the worst—is forced into the skin of the enemy, then, probably as the result of a reflex action, the integument over the poison glands is contracted and some of the secretion is forced along the groove in the spine. This poison either enters the wound, or may be discharged on to the surface of the skin and then be absorbed through the cut surface. It may happen that no evil effects result, perhaps owing to the failure of the fish to discharge its venom. I have heard fishermen say that they have been pricked by a Weever but not poisoned. As a general rule, however, a sting by this fish is poisonous.

Fishermen who have been stung say that the pain produced is so severe as to incapacitate them for some days, and that the pain and swelling produced by the poison may extend to the whole arm and shoulder. There may also be local necrosis. The effects are those characteristic of animal venoms, such as snake toxins, and it is very extraordinary that the nature of the poisonous secretion and of the intoxication produced by it, as well as the possibility of immunity, should not have been investigated.

There are few published accounts of the effects of the wound of a Weever, and I have not been conscientious enough to make vicarious experiments. The best account of the action of the poison is that given by Allman,* who caused a Weever to sting him in the thumb ; he found that the puncture gave rise to most excruciating pain, which lasted for an hour and a quarter, and was followed by swelling and inflammation. The swelling persisted for several days, and for a week pain was produced by pressure

* *See* Byerley, *Proc. Liverpool Lit. and Phil. Soc.*, Vol. V., 1849, p. 156. Parker gives a much more exact account of the anatomy of the poison secreting structures : *Proc. Zool. Soc.*, London, 1888, pp. 359-366, Pl. XVII. This paper contains a bibliography. Allman's paper is published in the *Ann. and Mag. Nat. Hist.*, Vol. VI., 1841, pp. 161-165.

over the wound. Fishermen usually say that the sting of a dead Weever is as painful as that of a living fish. Allman found, however, that inoculation from a sting by a fish that had been dead for twenty-four hours produced only a slight smarting. It is probable that in such an experiment toxin was not really injected or that the dose was a minimal one.

There are no recognised remedies against the sting, though fishermen have various specifics. Byerley relates that the Hoylake fishermen in 1848 were accustomed to treat wounds of this kind by the application of a poultice made with the viscera of Weevers; but Captain Eccles, Fishery Officer at New Brighton, who is a Hoylake man, tells me he has never heard of this remedy. His opinion is that the pain usually passes away about twelve hours after the infliction of the wound, when the tide is at the same height as when the sting was received. The poultice is an instance of sympathetic medicine so often employed by uneducated people,* and the belief in the association with the phase of the tide illustrates the curious way in which fishermen regard many different phenomena as dependent on the tides.

GREATER WEEVER. *Trachinus draco*, Linné.

Local name—STINGER.†

An occasional visitant to local waters.

The Greater Weever is certainly very much scarcer in the Irish Sea than the last species. I have only one record of its occurrence in Liverpool Bay. A specimen was taken some years ago by a local shrimper and sent to the fish-market in Liverpool, whence it was sent to me.

* A somewhat similar practice is stated by Fries to be observed in Sweden, *Scandinavian Fishes*, Vol. I., p. 130. This work also gives an interesting account of the effects of the sting of the Greater Weever.

† It is only very exceptionally that Cheshire fishermen see this fish.

It resembles the smaller species very closely, except that the colour is more yellow and there are several oblique bands on the sides ; yet it would certainly be identified as a weever by any fisherman who caught it, and it must be very uncommon, for most local shrimpers have never seen any weevers larger than *vipera*. It is much more abundant in St. George's Channel, where it is often caught by steam trawlers, and at times the fish actually reaches the public markets. It is a "south fish" which exceptionally migrates into Liverpool Bay about the same time and for the same reasons as the Bass.

There is no doubt that *Trachinus draco* is poisonous, but there are few observations on this point, most of the published work relating to the smaller species.*

A weever spawns in the inshore waters of Liverpool Bay in the months of May to July. Its eggs are commonly found in the collections of microscopic material taken in the tow-nets in the inshore part of the Bay. The distinction between the eggs of the two species is not known, and I am unable to say whether or not the ova identified as those of the weever are those of *vipera* or *draco*. The former species, is, however, so much more abundant than the latter that probably most of the eggs occurring in our area are referable to it.

CALLIONYMIDAE.

COMMON DRAGONET. *Callionymus lyra*, Linné.

Local names—HARDHEAD ; BISHOP ; SKULPIN ; DRAGONET.

Indigenous and abundant in Cheshire waters.

The Common Dragonet is a typical Cheshire fish and is fairly abundant in most parts of our area at all times of

* *Cf.* Fries, *Scandinavian Fishes*, Vol. I., p. 130. Death may result exceptionally from the effects of the poison.

the year. It is seldom that a haul with a shrimp-net is made without catching one or more examples of this species. The fish, especially the male, is very beautiful, being coloured in vivid tints of blue and orange. It spawns in local waters, and the eggs are fairly common in the material collected by tow-nets quite near the coast. It spawns in Cardigan Bay and offshore from Liverpool Bay in April and May, off Port Erin from March to June, and inshore in Cheshire waters from May to July. According to Day, the males prefer deeper water than the females, but I have not noticed this difference in distribution in our area.

The Dragonet carries sharp pointed spines on the bones of the opercula ; when the fish is carelessly handled these are apt to tear the skin, producing wounds which may become septic and suppurate. Fishermen, therefore, say that the Dragonet is poisonous, but there is no evidence in support of this supposition.

SPOTTED DRAGONET.

Callionymus maculatus, Rafinesque.

Possibly indigenous to Cheshire waters, but rare.

The history of the occurrence of this fish in British waters is interesting. Day only knew of the capture of one specimen, from the sea off the Shetland Islands. Later it was described from the Hebrides and Firth of Clyde by Günther, and from the west coast of Ireland by Holt and Calderwood. In 1897 it was dredged from Falmouth Bay, the first record from English waters.* It was next found—early in 1902—on the deposit grounds in Liverpool Bay by the Assistants of the Liverpool Museum, trawling from the steam-hopper "Beta," by permission of the Lancashire and Western Sea-Fisheries Committee. This capture and the subsequent identification of a specimen

* Holt, *Mar. Biol. Ass. Journ.*, Plymouth, Vol. V., No. 1, 1897, p. 90.

contained in a jar of store material at University College, Liverpool, were first recorded by Mr. Andrew Scott in 1903.*

The Spotted Dragonet is certainly much less common in British waters than the other species, but it is possible that the two have often been confused, for the chief difference seems to be that the second dorsal fin has two or three rows of spots in *maculatus*, whereas it is indistinctly blotched in *lyra*. The rarer form is also smaller than the other, and may therefore escape through the meshes of a trawl-net capable of retaining the larger species. Possibly a careful examination of the dragonets captured on our shrimping grounds would show that *maculatus* is commoner than is supposed.

The eggs of the dragonets are easily recognised in tow-net collections by the large size of the perivitelline space —that between the yolk and the shell. The outer membrane is furnished with little straight ridges arranged so as to form irregular polygonal figures. Ehrenbaum, in 1900, after investigating the ova of the two species, stated that the relative size of these polygonal areas was a distinction of specific value, the markings in *lyra* being further apart than those in *maculatus*.† These characters were utilised by Mr. A. Scott in the diagnosis of the fish ova occurring in the sea off the west coast of England, and from his observations it appeared that the distribution of the eggs of the two dragonets offshore was very similar, but that the ova of the smaller species did not apparently occur in the inshore waters of Liverpool Bay.‡ Subsequently, however, Professor Ehrenbaum informed me that he no longer regarded the size of the reticulations on the shells of the eggs of the dragonets as of specific value, so that it is doubtful whether we can deduce anything of value as to

* Herdman, *Liverpool Biol. Soc. Proc. and Trans.*, Vol. XVII., 1903, p. 41.

† *Wissenschaftliche Meeresuntersuchungen, Kiel Komm.*, Bd. 3, Abth. Helgoland, Heft 2, p. 294, 1900.

‡ *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1905, p. 33.

the distribution of the two species in local waters from the identification of eggs. Probably the majority of the eggs identified as those of the dragonets in Liverpool Bay are to be regarded as spawned by *C. lyra*.

BLENNIIDAE.

BUTTERFLY BLENNY. *Blennius ocellaris*, Linné.

Rare in local waters.

The Butterfly Blenny is very rare in the sea immediately off the coast of Cheshire, and the only record which I can find is one by T. J. Moore,* who found an example at the mouth of the Mersey. It is apparently a fish which, like the wrasses and others, preferring rocky grounds and sea-weeds, does not find a congenial habitat on most of the sea bottom in our area.

CAT FISH. *Anarrhichas lupus*, Linné.

Very rare in Liverpool Bay.

The Cat Fish is very rare in the sea off the whole west coast of England. Professor White records having found young specimens in the Menai Straits,† but I have not seen the species anywhere off the coasts of England or Wales. The only record of the occurrence of the Cat Fish in local waters is that quoted by Herdman and Dawson,‡ who mention that the stock books of the Liverpool Museum contain the record of a specimen taken near the "Rock Buoy" in the Irish Sea. Presumably some buoy in the Rock Channel is meant.

* *Naturalists' Scrap Book*, p. 49.
† Herdman and Dawson, p. 42.
‡ p. 42.

PHOLIDIDAE.

BUTTER FISH. *Pholis gunnellus* (Linné).

Indigenous and fairly abundant in shallow water in Liverpool Bay.

The Butter Fish is far more common among rock pools, in weedy grounds, and on rough parts of the sea bottom than on sandy grounds, and prawners often catch it. But it occurs not uncommonly on the sandy shrimping grounds off the estuaries of the Dee and Mersey, and most local fishermen are familiar with its appearance. I have often seen it in the catches made by the shrimp trawls. It is a pretty little fish, which lives well in small sea water aquaria, probably owing to its distinctively shallow-water habits. Its smooth skin and eel-like movements—characters which have probably given rise to its trivial name—make it difficult to hold in the hand. Its eggs are heavier than water; the fish carries them during the period of incubation rolled up in a ball, which is temporarily attached to the body of the parent, male or female.

GADIDAE.

Sub-order *ANACANTHINI.*

COD. *Gadus callarias*, Linné.

A seasonal migrant in Liverpool Bay; generally distributed and abundant, and spawning there. Very abundant in the immature stage.

The Cod is a "north fish," and occurs in greatest abundance in cold sub-arctic waters, or in a mixture of Atlantic water with that derived from the land. The greatest fisheries are those off the Newfoundland Banks and off the Lofoten

Islands in Norwegian waters. In the former area the fish inhabits the mixture of Arctic and Atlantic water forming the Labrador Current, and in the latter a mixture of Atlantic water with that originating from the land. It is therefore of interest that the Cod only approaches the west coast of England at the time when the temperature of the sea is falling towards its annual minimum, and that it here inhabits water of somewhat similar salinity to that of regions where it is found in greatest abundance.

The Cod first appears in our waters about the end of November, and is most abundant in January or February; after March or April few are caught. It is said to come to Liverpool Bay from the south, through St. George's Channel, and perhaps the majority of the fish caught locally do take this course, but there is probably also a migration into Liverpool Bay from the north through the North Channel. This seasonal migration is for the purpose of spawning; the fish come into the shallow water near the shore, or to the banks, in order to emit their eggs. After the spawning period is over few Cod remain in local waters. Cod are supposed by some fishermen to approach the coast of England and Wales in pursuit of the Herring shoals; while this may be true, it is more likely that the necessity for spawning in shallow water, where the larvae find a suitable habitat, is the main cause of the migration.

Cod are generally distributed along the west coast of England during the winter and spring; they are fairly abundant at that time both in the territorial and extra-territorial waters from the Liverpool North-west Lightship so far north as Blackpool. They form the material for a fishery of some local importance during the early months of the year. They are caught both by trawling and lining, but in our area, as elsewhere, the latter form of fishing is now of much less importance than the former. Both the first class sailing trawlers (smacks) and the steam trawlers catch a considerable number of Cod during the fishing season. A catch of thirty-three head of Cod during a four and a half

hours' drag with a trawl-net is perhaps well above the average result, but I have heard of several such catches. Cod fishing by lines is practised in our area chiefly near New Brighton and Blackpool. Formerly the winter Cod line fishery at New Brighton was of some importance, and long lines carrying about sixteen hundred hooks were employed; at the present time lines with from six hundred to one thousand hooks are used. Formerly the favourite baits were squids and whelks, but now the Cheshire fishermen bait their Cod hooks chiefly with "flukes," *i.e.*, Plaice or Dabs.

The Cod spawns in local waters when it has attained an age of four or five years and a length of twenty-five to thirty inches. Spawning takes place offshore in water of about ten fathoms or rather less. The breeding season lasts from February to May, during which months the eggs are to be found among the plankton. The maximum, that is, the time when the majority of the fish appear to spawn, is about the middle and end of March, just after the yearly minimum of sea temperature. Probably the majority of the eggs contained in the ovaries of a Cod ripen and are emitted at about the same time; a Cod roe from which the eggs run out when the organ is cut and which is soft and translucent in appearance is the ovary of a fish about to spawn. In a large mature Cod the two ovaries may contain so many as five million eggs. It has been found that there are, apparently, two spawning periods for the Cod in the North Sea—the spring and autumn. In the Irish Sea, however, Cod eggs are only found in the spring.

The pelagic eggs are widely distributed by the agencies of tidal and wind currents; they occur very commonly in the plankton taken in spring along the coasts of Lancashire and Cheshire. They are perhaps the most abundant fish ova found in local waters. The larvae hatch out from the egg in from eight to twenty days according to the temperature of the water. The recently hatched larva is pelagic and drifts about near to the surface of the sea; by the

middle of the year it has grown to about two inches in length and is recognised as a young Cod. Local specimens of this size have a well marked "chessboard" pattern of grey pigment on the sides of the body. When a little smaller than this, and still pelagic in habit, they are often to be observed associated with the large "jelly-fishes" (*Rhizostoma*). The medusa swims near the surface of the sea, partly drifting and partly propelling itself by means of rhythmic contractions of its bell, and a swarm of small gadoid fishes often clusters underneath the bell. Possibly the little Cod seek the shade of the jelly-fish, but it may also be that they there find protection, for the larger medusae are generally avoided by other marine animals.

About midsummer, or a little later, the young Cod abandon the pelagic habit and seek the sea bottom. They are said to prefer weedy or rocky grounds near the shore, but in the Cheshire area there is little of such sea bottom, and large numbers of young Cod may be taken on sand. I give as an instance one haul made on the 14th of October, 1895, near the Deposit Buoy, where the bottom is sand and mud, when two hundred and forty-nine Codling, all about four inches in length, were taken in one drag with a shrimp trawl lasting for about one hour. Catches like this are not uncommon, though immature Cod of this size are far less abundant in local waters than Whiting. But it may be that the young Cod prefer to inhabit the few patches of rough bottom in our area.

The rate of growth in Cheshire waters has not been specially investigated, but probably does not differ much from that observed in the North Sea. There the Cod attains to from ten to fifteen inches at the end of its second year and to about twenty inches at the end of its third year ; in the fourth year it probably spawns for the first time. Young Cod are called "Codling" until they are about twenty inches in length. They are generally distributed in the inshore parts of the Irish Sea, but they are never so abundant as Whiting during the Whiting season. They are caught

both by trawls and lines. Up to the Codling stage the fish probably live entirely in the Irish Sea, migrating to and from the shore waters. But after attaining this size they probably migrate out from this area, returning only when about to spawn for the first time.

The Cod is a voracious fish, eating practically whatever it can catch. In Liverpool Bay it feeds chiefly upon crustacea, such as crabs (*Portunus*, *Carcinus* and *Pagurus*, particularly the last) and shrimps. Fishes, such as "flukes," young Herring and Sprats, are also largely eaten by locally caught Cod, which are probably responsible for a good deal of destruction of young immature Plaice, but not Soles. I have seen fifteen fairly large specimens of the crab *Portunus* in the stomach of a single Cod. In another, which I dissected, the food remains were :—thirty-three Sprats or young Herrings, one Dab, eight inches long, three Plaice or Dabs, three to six inches long, six shrimps, one sea mouse (*Aphrodite aculeata*, Linné), and one piece of coal about two ounces in weight. The piece of coal was probably attached to some sessile animal, perhaps a sea anemone, when swallowed by the Cod. I have seen a Whiting ten inches in length in the stomach of a Cod twenty-seven inches long. Sand Eels are very commonly eaten.

Malformations are not uncommon among Codling, but not so common in full-grown fish ; probably the occurrence of a malformation or deformity lessens the chance of survival of the individual exhibiting it. The backs of the fish are often bent or twisted, and sometimes deformation of the mouth, due to the arrested growth of the lower jaw, is present.

The fish is so voracious and has such a variety of food animals that it is the host of numerous parasites. Those which are recorded from Cod caught locally are as follows :—Parasitic copepods—*Bomolochus soleae*, Claus, *Caligus rapax*, Müller, *Lernea branchialis*, Linné, *Anchorella uncinata* (Müller)—occur on the gills, or on the internal walls of the mouth, nasal or opercular cavities. Nematode worms

are of almost invariable occurrence in the peritoneal cavity or in the lumen of the alimentary canal, but I have not been able to identify the species ; probably several occur. The tapeworm, *Bothriocephalus rugosus*, Goeze, occurs with its head imbedded in the pyloric caeca ; I have seen as many as twenty of these tapeworms, each at least two feet in length, in the alimentary canal of one Cod. This worm occurs almost invariably in Cod caught in Liverpool Bay. Distomids are not present—at least I have not yet found any in locally caught Cod. When left on the hooks for some time Cod may literally be devoured by the isopod crustaceans *Aega* or *Idotea*, which burrow into the body cavity, destroying the flesh and internal organs.

Apart from these pests Cod have few enemies. Large fish are only eaten by Porpoises. Small Codling may be devoured by skates, rays, and dog fishes, or even by Whiting, Turbot and Brill. The depredations of dog fishes are confined mainly to the destruction of Cod or Codling left on the hooks when the lines cannot be fished for several days on account of bad weather, but the damage done in this way is at times considerable.

HADDOCK. *Gadus aeglefinus*, Linné.

A migratory fish, mainly seasonal in its occurrence, spawning, but not very abundant in the adult stage in Liverpool Bay.

The most notable feature in the natural history of the Haddock in local waters is its capricious habit. At the present time the fish is not at all abundant in Liverpool Bay ; it is, of course, caught by the trawlers during the spring fishery, but it is not a conspicuous part of their catch. The Haddock, more than any other Irish Sea fish, comes and goes, to all appearances quite irregularly. Generally speaking it visits the Irish Sea during the spring and spawns there, but the appearance of the fish in great shoals is

irregular. Periods of great abundance alternate with periods when the fish is very scarce, and our experience of these alternations is not extensive enough to enable us to say whether or not these phases of abundance are correlated with the character of the weather from year to year.

Fishery statistics are not perfect enough to make it possible to give an account of the movements of the Haddock, and I can quote only the results of the experimental trawling work of the Lancashire and Western Sea-Fisheries Committee. These observations were made off the estuaries of the Dee and Mersey by Captain Eccles, who used a trawl-net from a sailing boat. They extend over the period 1893–1909, and show that 1893 was the beginning of a period when Haddock were very abundant in strictly local waters. From 1894 to 1895, and 1897 to 1898 were the seasons when the fish was most plentiful ; at times during these years extraordinarily large catches were made. As a rule a trawl-net of twenty-five to thirty feet in spread was used, and was dragged for about one hour, that is, over a strip of sea bottom about two to two and a half miles in length. I quote here some of the larger catches made :—

November 15th, 1893.—270, average weight $1\frac{1}{4}$ lb.
January 15th, 1894.—270, average length 14 inches.
October 3rd, 1894.—208, length of majority 10–14 inches.
October 3rd, 1894.—444, average length 13 inches.
November 22nd, 1898.—448, majority $10\frac{1}{4}$–19 inches.

During these same years unusually large catches of Haddock were made by the Hoylake and Fleetwood trawlers and by the second class boats belonging to Liverpool and Southport. These vessels worked in quite shallow water along the Cheshire and Lancashire coasts between Air Point and Southport, sometimes coming close to Liverpool Bar and working a great deal in the territorial waters. It was reported* that in 1894 a first class sailing trawler,

* Dawson, *Lancashire Sea-Fisheries Superintendent's Report,* December, 1894.

fishing just off the mouth of the Mersey, could take twenty boxes of Haddock (each box containing eighty pounds of fish) in one drag of four and a half to six hours. In 1898 thirty boxes of Haddock could be taken in a six hours' drag just off Liverpool Bar. One skipper is said to have sold his day's catch for £35.* These were very prosperous times for local trawlers, but apparently it was only in shallow waters that this extraordinary wealth of fish was present. The exceptional conditions led to considerable friction between the trawlers and the Fishery Committee, for at that time the fishing regulations prescribed a mesh of the minimum size of one and three-quarter inches from knot to knot, and this was unfortunately too large to retain all the marketable Haddock which could be caught—the mesh being designed to prevent the capture of immature and comparatively valueless Plaice. The minimum trawl mesh was afterwards reduced to one and a half inches, but since 1898 the Haddock have not appeared in anything like the same abundance, and at the present time (1909) they are only caught exceptionally in the inshore waters of Liverpool Bay.

The Haddock spawns in local waters, and indeed over the greater part of the Irish Sea out to the twenty-fathom contour line. The eggs are pelagic and are taken every spring in the plankton collected in Liverpool Bay. The Haddock must therefore be present near our area in sufficient abundance to produce eggs which are conspicuous in the plankton; this, however, does not mean that they are abundant from the fisherman's point of view. Possibly a considerable proportion of the eggs found in the inshore waters of Lancashire and Cheshire are spawned in St. George's Channel, and enter Liverpool Bay as the result of the surface drift of water from the south. February to April is the local spawning period. The life-history of the Haddock resembles that of the Cod, but is

* Dawson, *Lancashire Sea-Fisheries Superintendent's Report*, December, 1898.

not so well known. The ova are very similar to those of the Cod, and the larvae hatch in from ten to eighteen days according to the temperature of the sea. The larvae are pelagic and are taken among the plankton, but about the middle of the year the little fish assumes the demersal habit, and is then taken at the bottom of the sea. It prefers those places where the bottom consists of fine sand and the water is warm. During the months of July to September great numbers of young Haddock about three to four inches in length may be taken in the shrimp trawls on the banks outside the Mersey and Dee Estuaries. They are hardly ever so plentiful as Whiting during the season of that fish; thus, a capture of four hundred and fifty immature Haddock in a one hour drag outside the Mersey Banks is the largest of which I can find any record. Nevertheless, the Cheshire nursery grounds serve for the Haddock as well as for many other fishes.

The Haddock is a greedy eater and has a wide selection of food animals. It is said to devour great quantities of Herring spawn, following the shoals at their breeding time for this purpose. This may be the case in the sea to the south and west of the Cheshire area, but I have no record of such a habit here. In Liverpool Bay the Haddock usually eats crustaceans and fish, as for instance shrimps, crabs, Sprats and Herrings. It also feeds on echinoderms, for the brittle star, *Ophiura*, is often found in its stomach. In deeper water the fish appears to grub among the bottom deposits for its food, for a peculiar callianassid crustacean, *Upogebia*, has been found in the stomachs of Irish Sea Haddocks, but not elsewhere. The delving action of the fish cannot apparently be imitated by any form of fishing apparatus.

The parasites recorded from the fish are mostly those also found in the Cod. The remarkable copepod *Lernea* is fairly common. Haddock caught in Liverpool Bay often contain a myxosporidian parasite, *Sphaerospora platessa*, Woodcock, a form first described from Irish Sea Plaice.

This sporozoon forms cysts which are embedded in the cartilage of the chondrocranium. The trematode *Gasterostomum gracilescens* (Rudolphi) is also frequently found in locally caught fish. It inhabits the brain membranes in its larval stage, the mature worm being found in the Conger. I have never seen deformed Haddock from local waters.

WHITING. *Gadus merlangus*, Linné.

Local name—WHITLING.

A seasonal migratory fish, spawning in Liverpool Bay; common in the mature stage, and exceedingly abundant in its immature condition in shallow waters.

The Whiting is the most abundant Irish Sea gadoid fish. It is generally distributed all along the west coast of England and Wales. It is fairly common in the mature stage in the offshore waters of Liverpool Bay, but not nearly so abundant in the shallow grounds near the shore. It is very abundant during the months February to May in the sea between the Cumberland coast and the Isle of Man, where it spawns in numbers; this locality appears to be the centre from which the Whiting that are found in the Cheshire area proceed. The Whiting is a distinctly seasonal migrant which enters the Irish Sea at the beginning of the year, when the temperature is falling towards its annual minimum, then spawns and disappears again. Unlike those of the Haddock, its migratory movements are regular, so that the appearance of the fish can generally be depended upon—allowing, of course, for unperiodic variations in the advent of the shoals. It is of considerable importance as an economic fish.

The life-history is similar to that of the Cod and Haddock; the eggs are pelagic, resembling those of these two species. The Whiting spawns in the late spring; the eggs are found in the plankton of Liverpool Bay in March, and offshore in

February to April. They become generally distributed over the sea between England and the Isle of Man. The larva hatches out in from ten to eighteen days according to the temperature. The pelagic habit is maintained until the middle of the summer, when the little Whiting sinks to the sea bottom for the rest of its life. About July they begin to appear in Cheshire waters, and from this month to near the end of the year the Whiting, in the immature stage, is one of the most abundant local fishes. Seldom can a haul with a shrimp trawl be made during those months on the grounds outside the Dee and Mersey without catching a number of young fish. I quote here several of the larger catches made by Captain Eccles on the grounds in question :—

15th September, 1903	..	..	1,821 Whiting.
17th September, 1903	..	..	585 ,,
17th August, 1904	..	..	2,684 ,,
17th August, 1904	..	..	1,900 ,,
17th August, 1904	..	..	1,512 ,,
25th August, 1904	..	..	787 ,,
28th August, 1904	..	..	2,252 ,,

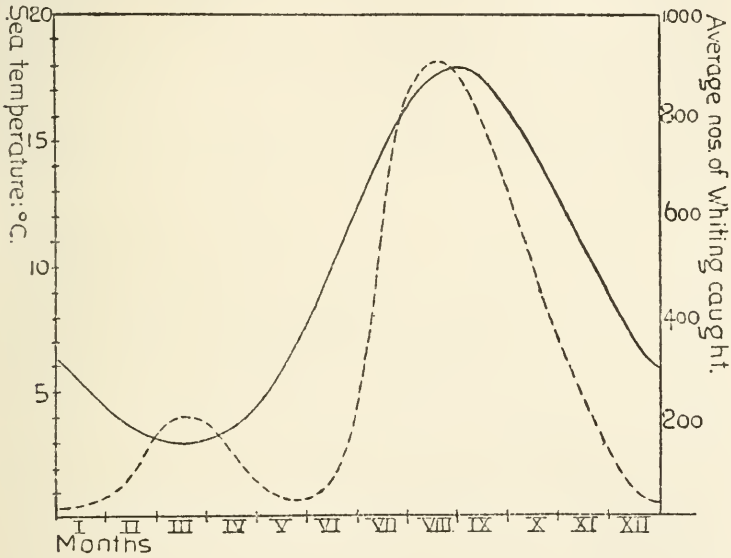
All these results represent catches made with a small trawl working for about an hour's drag.

The seasonal variation in the abundance of Whiting on the Cheshire fishing grounds has been worked out by Dr. Jenkins and myself from the statistical results already referred to.* The curve given opposite shows how the abundance varies according to the season.

There are two periods when the immature Whiting are abundant — in March, when the average rises to about two hundred fish per haul, and in August, when the average is nearly one thousand per haul. The maximum in March is doubtless due to the segregation of immature Whiting of the previous year's spawning. The fish represented by the March maximum have probably remained on the

* *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1905, p. 103.

grounds throughout the winter, but are crowding together because of some change in the condition of the sea, or because of the increased abundance of food. After this the average catch falls until June, when it rises very rapidly to the principal maximum in August. This rise is due to the great increase of Whiting which have been spawned in the same year and are becoming large enough to be taken in the



Graphic representation of the seasonal variation in average numbers of immature Whiting caught per haul of the shrimp trawl off the Dee and Mersey. The continuous line shows the temperature of the sea, and the broken line the average catches of fish. (From *Lancashire Sea-Fish. Laby. Report* for 1905, p. 103.)

shrimp trawls. After August they probably disperse into deeper water. The figure shows the temperature of the sea on the shallow-water Cheshire grounds, and it is interesting to find that the sudden drop in the average number of immature Whiting caught coincides with the decrease in the temperature of the water.

These immature Whiting are, with the occasional

exception of Sprats and Herrings, the most abundant fishes inhabiting the inshore waters of Liverpool Bay. The catches represented in the curve are average monthly ones, and the maximal catches are greater than are those of Dabs or Plaice, the two next most abundant species. The greatest single catch recorded is one of about six thousand fish ; this was made by Captain Eccles as the result of a drag for an hour and a half on the deposit grounds off the Mersey Estuary. The fish is one which shows no signs of diminishing. When the average catches for successive years are plotted on a chart, month by month, the curve obtained is an irregular one. The maximum abundance appears to have been observed in 1895, but it is probable that there is no definite tendency, either upwards or downwards.

The Whiting, like the Cod and Haddock, is a voracious fish. In our area the nature of the food varies with the phase in the life-history. When very young—about four to eight inches in length—the fish subsists largely on small crustaceans, such as shrimps, the schizopod *Mysis*, the isopod *Idotea* and the amphipods *Gammarus* and *Corophium*. Later the Whiting eats the larger crustaceans, such as crabs, and fishes, especially Sprats and Sand Eels. It is cannibalistic, certainly more so than any other species of fish found in our area ; I have often found Whiting with other Whiting not much smaller than themselves in their stomachs.

The Whiting harbours more parasites than even the Cod or Haddock. All the parasitic copepods found on the Cod are met with in the Whiting, and the remarkable *Lernea* is much more common in this fish than in the Cod. *Lernea* is a peculiarly ferocious parasite ; I have often seen it with its anchor hooks and suctorial mouth directly embedded in the ventral aorta of the fish, draining the heart's blood. The ectoparasitic trematode *Octobothrium merlangus* (Kuhn) is common in locally caught Whiting ; it is nearly always found adhering to the gills. The internal trematodes

Derogenes varicus (O. F. Müller) and *Hemiurus communis*, Odhner, occur in the alimentary canal, and *Gasterostomum gracilescens* (Rudolphi) inhabits the cranial cavity, as in the Haddock. The gephyrean *Echinorhynchus acus*, Rudolphi, occurs in the intestine. Locally caught Whiting almost always contain large numbers of the larval tapeworm *Tetrarhynchus erinaceus*, van Beneden, which is found in local gurnards ; unidentified nematodes are as common. Quite recently I obtained a locally caught Whiting which was infested with the peculiar myxosporidian *Myxobolus esmarkii*, a form first described by Woodcock from Lancashire waters. This parasite inhabits the cornea, spreading over the eye of the fish until a partial cataract is produced. The myxosporidian *Sphaerospora platessa*, Woodcock, is common in the cartilage of the cranium, as in the case of the Haddock.

The three species, Cod, Haddock and Whiting, possess large swim-bladders. When the fish is caught in the deeper waters offshore—fifteen to twenty fathoms—in large quantity, a curious sight is sometimes witnessed, for the release of pressure as the trawl-net comes up from the sea bottom causes the gas in the bladders to expand, with the result that the mass of fish imprisoned in the narrow " cod-end " of the net swells to such an extent that the end of the net may be burst open, allowing the fish to escape. In such circumstances the fish are lighter than water, and, being unable to go down, float on the surface. This also happens when large Cod are caught under any circumstances.

COAL FISH. *Gadus virens*, Linné.

Rare in Liverpool Bay.

The eggs and larvae of the Coal Fish are certainly present in the territorial waters of Liverpool Bay from Red Wharf

Bay to Blackpool. The fish itself appears to prefer rocky coast and probably spawns somewhere in the Irish Sea, the St. George's or the North Channel in the winter and spring. The young forms, up to about one quarter to half a pound in weight, are common enough in shallow waters in North Lancashire, but I have no personal knowledge of their occurrence in the Cheshire area. It is, however, almost certain that they do exist there, since the larvae are to be found among the local plankton, though curiously enough they do not appear to have been recorded.

BIB. *Gadus luscus* (Willughby).

Local names—Poor Cod ; Miller's Thumb.

Probably indigenous to Cheshire waters.

The Bib is generally distributed in the Cheshire and Lancashire territorial waters, where it is most plentiful in the shallow estuaries and bays. It grows to be about ten inches in length. It is never very abundant, but often examples are taken in the fish and shrimp trawl-nets. It spawns in the spring, and the eggs, which are pelagic, are found in the local plankton during March and April. It is sometimes taken in stake-nets, but is a fish of very little economic importance in the Cheshire area.

A copepod parasite *Lernea lusci*, Bassett-Smith, has been recorded from the gills of Bibs caught locally, and appears to be restricted to this host.

POOR COD. *Gadus minutus*, Linné.

Indigenous, but not abundant in Cheshire waters.

The Poor Cod has a similar distribution to that of the Bib. It is I think, more abundant in local waters, but is never

particularly plentiful. It is taken only in the shrimp trawls, being too small to be caught in the fish-nets. Byerley mentions that, in 1854, four or five examples could generally be taken in a single shore pool, that they were so abundant that poor people gathered them for food, and that the numbers of the fish were increasing. Possibly he meant *Gadus luscus*, for the Poor Cod is rather small to be used as a food fish. It is very difficult to be sure which of these two latter species of *Gadus* one has to deal with, for the descriptions given in Day's *British Fishes* are not very reliable. There has always been some confusion between the two.

POLLACK. *Gadus pollachius*, Linné.

Local name—WHITLING POLLACK.

An occasional visitant to Cheshire waters.

Mature Pollack prefer the sea bottom off rocky and weedy coasts, such as that of the Isle of Man, and therefore are not often observed off the sandy coasts of Lancashire or Cheshire. I have never seen one which was certainly caught locally and do not know of any reliable record of the occurrence of the mature fish in strictly Cheshire waters. They occur to the west off the coast of Wales, and probably spawn somewhere off Liverpool Bay. Immature specimens are sometimes taken in the shrimp trawls working off the estuaries of the Dee and Mersey. The eggs are probably pelagic, but there is no published account of them, nor of the spawning habits of the Pollack.

FORKBEARD. *Phycis blennoides* (Brünnich).

Very rare in Liverpool Bay.

The Forkbeard is certainly the rarest of the *Gadidae* inhabiting the Cheshire sea area. I can find only a few records of its occurrence in recent years. Herdman and Dawson mention a capture off the coast of Flint. Collingwood refers to a specimen, three feet long, in the British Museum which is labelled "Liverpool."* It is a summer migrant, and has been taken occasionally in Rhos Weir to the west of Liverpool Bay and in Barrow Channel to the north.

LING. *Molva molva* (Linné).

A very rare visitor to Cheshire waters.

The Ling is a northern fish, and prefers deeper water than is found off our area. A small specimen was taken by Captain Eccles while trawling in Crosby Channel some years ago, and this is the only local record which I have come across. Byerley's statement—"About the coast. Rocks at Runcorn"—requires confirmation.

FIVE-BEARDED ROCKLING. *Onos mustela* (Linné).

Probably indigenous to Cheshire waters, but rare.

The Five-bearded Rockling prefers the sea bottom off a rocky or weedy coast, so that the opportunities of observing this fish in Cheshire waters are few; it does,

* *Liverpool Lit. and Phil. Soc. Proc.*, Vol. XVIII., 1865, p. 162.

HILBRE ISLAND, LOW TIDE.

however, occur occasionally in the catches made by the shrimp trawls working off the estuaries. Byerley records it from the Mersey near Hale, and Herdman and Dawson from Hoylake and from Newcome Knoll off the Burbo Bank.

THREE-BEARDED ROCKLING.

Onos tricirratus (Brünnich).

Indigenous to Cheshire waters, but never abundant.

The distribution of the Three-bearded Rockling is similar to that of the last species. It was recorded from the Dee by Willughby, and has been taken at Hilbre Island and Hoylake,* but it is a rare fish in Cheshire waters. There is an undated specimen from the Mersey in the Warrington Museum.

The rocklings appear to be characteristic inshore spawners. Their eggs, which are pelagic, occur very frequently in the plankton taken from the territorial waters between Blackpool and Red Wharf Bay; their abundance and wide distribution indicate that the species are more plentiful than the fishing experiments lead us to believe. The range in time of these eggs is rather unusual; my colleague, Mr. A. Scott, has recorded them during the months March to September; but the characters differentiating the eggs of the two species have not been made out with certainty; it is probable that the eggs identified as those of rocklings are really spawned by two species reproducing at different times of the year.

* Herdman and Dawson, p. 49.

MUGILIDAE.

Sub-order *PERCESOCES.*

LESSER GREY MULLET. *Mugil chelo,* Cuvier.

Local name—MULLET.*

A migratory gregarious fish ; not abundant in Cheshire waters.

The Grey Mullet is not an abundant fish in Liverpool Bay ; there are comparatively few records of its occurrence. It is caught in stake-nets off Formby and Southport, but never, to my knowledge, in the trawls. Although a migrant, appearing in local waters during the summer months, it apparently occurs all the year round in some west coast localities ; numbers of Grey Mullet are said to occur in the Cavendish Dock at Barrow. Probably the fish spawns in local waters, for my colleague, Mr. A. Scott, has taken quantities of the young stages in ordinary tow-nets set across shallow gutters in Morecambe Bay. I have seen large numbers of young Mullet about three inches in length in the dock at Fleetwood. Nothing is known of its spawning habits.

Grey Mullet are shy, easily frightened fishes. They take a bait with reluctance, and the best bait appears to be a piece of dough. They are pelagic fish, swimming at, or near to, the surface of the water ; when they encounter an obstacle they leap. Sometimes other nets or bundles of twigs are set in front of the seine-net used for the capture of Mullet ; the fish when they reach these obstacles leap over them into the net proper.

During the last year or two a curious method of fishing has been practised at New Brighton. A large net made of rather fine string is stretched on a ring about four to six

* "Mullet" in Lancashire are always Grey Mullet. The Red Mullet is unknown in local waters.

feet in circumference ; this contrivance, being attached to bridles and a tow-rope, is lowered over the pier into the water and allowed to rest on or near the sea bottom. Several men hold the end of the tow-rope, whilst another watches until a Mullet swims over the mouth of the net, and then shouts to his companions. The net is then hauled as rapidly as possible, so as to cause the fish to strike into it. As a rule, the Mullet is frightened and escapes from the net before it can be hauled to the surface. Captain Eccles, however, informs me that occasionally one or two fish may be caught in a day.

The Grey Mullet is a true vegetarian, and feeds by browsing on the fine seaweeds which cover rocks, stones and piles. I have dissected many specimens caught locally and have never found any remains in the stomach indicating that the fish eats animal food ; indeed one usually finds in the stomachs and intestines a large amount of sand and mud, mixed with remains of seaweeds and a quantity of diatoms, which belong as a rule to the genera *Navicula* and *Pleurosigma*. These organisms are very abundant in local waters, inhabiting the surface of the seaweeds, and even the upper layers of the sand in the shallow bays and estuaries, especially where the tide does not run with great force. They are taken into the stomach of the fish with the seaweed. The algae probably contain a fair amount of nutriment, but little is contained in the substance of the diatoms, for in composition these organisms may be likened to straw when regarded as food. The fish must, however, ingest a comparatively large quantity of weed in order to get a reasonable quantity of pabulum. The alimentary canal of the Mullet shows a well marked differentiation from that of other fishes in that it is unusually long. It conforms to the herbivorous type of structure in that there is a fairly large caecum, while the intestine is thrown into close convolutions ; an adaptation associated with the necessity for the digestion of large quantities of vegetable food.

AMMODYTIDAE.

GREATER SAND EEL.

Ammodytes lanceolatus, Lesauvage.

Indigenous to the Cheshire area, but not abundant.

The Greater Sand Eel is the rarer of the two species of *Ammodytes* found in Liverpool Bay. It has been recorded from the estuary of the Dee.*

LESSER SAND EEL.

Ammodytes tobianus, Lesauvage.

Indigenous to Cheshire waters and fairly abundant.

The Lesser Sand Eel is much more abundant in Cheshire waters than the last species. It is taken very frequently in the shrimp trawl-nets worked off the two estuaries, though it does not appear to be so abundant there as on similar grounds in Morecambe Bay. The fish inhabits the sand, living at some depth below the surface when the tide is out, and therefore it is not often seen. There is no regular fishery for it in local waters. It is, however, of considerable importance as constituting the food of many piscivorous fishes, such as the Bass, Whiting, Brill and Turbot ; the frequency with which it occurs in the stomachs of fishes of these species indicates that it is really more abundant locally than ordinary observations would lead us to believe.

The life-history of the sand eels in local waters have not been specially investigated.

* Herdman and Dawson, p. 49.

SCOMBRESOCIDAE.

GARFISH. *Rhamphistoma belone* (Linné).

Local names—SEA NEEDLE; GREENBONE.

A migratory gregarious fish, at times common in local waters.

The Garfish is much less abundant in Liverpool Bay than in the sea off the coasts of Wales, especially in Cardigan Bay. It is a "south fish," which enters our area when the temperature of the sea rises to near its maximum at the beginning of the autumn. It is fairly common at times and examples are taken in the stake-nets. It is an edible fish, but there is no regular fishery for it in local waters.

Local records are fairly numerous. Byerley states that it occurs in the Dee during the Mackerel season, and Herdman and Dawson mention that it has been found in the Manchester Ship Canal at Eastham and in the Queen's Dock at Liverpool. One fairly large specimen, taken from the Dee between Saltney Bend and the Chester Sewage Works, was examined by Mr. Robert Newstead. This fish weighed one pound nine ounces and was two feet eight and a half inches in length.

SYNGNATHIDAE.

Sub-order *CATOSTEOMI.*

PIPE FISH. *Syngnathus acus*, Linné.

Local name—HORN EEL.

Indigenous, but not common in Cheshire waters.

The Pipe Fish has been recorded from the Dee by Byerley and Mr. A. O. Walker, and from the Mersey near New

Brighton by T. J. Moore.* I have occasionally seen it in the catches from the Mersey shrimping grounds by the trawl-nets, especially when a large number of young Herrings or Sprats had been taken; the Pipe Fish is, however, usually able to escape through the meshes of the nets employed for shrimping, so that the occurrence of the fish under these circumstances does not really give any idea of its abundance. It appears to prefer stony and weedy sea bottoms, so that the opportunities of observing it in local waters are limited.

SNAKE PIPE FISH. *Nerophis aequoreus* (Linné).

Rare in Cheshire waters.

The Snake Pipe Fish was recorded from the Dee by Byerley, and there are examples in the Grosvenor Museum, Chester, which were taken in the Dee; one of these was obtained from a fisherman by Mr. A. Newstead in 1905.† I have never seen it in the catches made by the shrimp trawls.

GASTEROSTEIDAE.

THREE-SPINED STICKLEBACK.
Gasterosteus aculeatus, Linné.

Local names—Jack Sharp; Stickleback.

Abundant throughout the county.

The Three-spined Stickleback is abundant and widely distributed throughout Cheshire, inhabiting ponds, meres,

* Herdman and Dawson, pp. 56, 57.

† *Chester Soc. of Nat. Sci., etc., Report* 19, 1889–90, p. 17.

ditches and streams. It is found in the hill-country in the east of the county as well as in the lowlands. It is, of course, characteristically a freshwater species, but occurs exceptionally in the sea; Byerley refers to it in brackish water at Wallasey Pool, and I have examined one specimen caught in a shrimp trawl off the Mersey Estuary. It is a very small fish, and cannot often be taken in the shrimp-nets; but it must be very rare in the sea, for Captain Eccles, who sent me the specimen to which I refer, had not before seen a sea fish like it, though he has had great experience of the fishes of the district.

The Three-spined Stickleback exhibits great variation; Day* describes six varieties. I have not paid particular attention to the varieties occurring in Cheshire waters, but the semi-marine specimen referred to above certainly was the variety *trachurus*, Cuvier and Valenciennes. It was either a spent female or an immature fish—probably the latter.

On October 1st, 1909, Coward found a number of Three-spined Sticklebacks, together with quantities of Sprats and young Herrings, on the marsh on the landward side of the Burton Cop. The fish had come up with the tide, and had been left in the rapidly draining pools as the water receded. Out of five submitted to me only one was referable to the marine form, *G. aculeatus trachurus*, the other four being the typical *G. aculeatus gymnurus*, Cuvier. The Sprats and Herrings died long before they were actually uncovered by the water, but some of the Sticklebacks were still living in the wet grass from which the water had drained into the neighbouring gutter. This gutter, up which the fish had come, is tidal and consequently salt.

Sticklebacks are said to be frequent hosts of the cestode *Ligula*, but so far I have not been able to record this parasite from fishes caught locally.

Coward submitted a number of Three-spined Stickle-

* *British Fishes*, I., pp. 238, 239.

backs, collected in various localities in Cheshire, to Mr. Richard Elmhirst of Millport, who found three varieties represented. The fish were taken from a stream with sandy bottom close to where it enters the river Bollin, Dunham Massey; from a clear stream which runs into Marbury Mere near Northwich; from a sandy tributary of the Gowy at Beeston; from a pond with muddy bottom at Aston-by-Budworth; from a muddy reservoir at Millbrook near Mossley, five hundred feet above the sea, and an artificial pond at Broadbottom at about six hundred feet altitude. In all six localities *G. aculeatus gymnurus*, Cuvier, was present. The short-spined *G. aculeatus brachycentrus*, Cuvier and Valenciennes, was present in the Dunham Massey stream, and the four-spined *G. aculeatus spinulosus*, Jenyns, was amongst the fishes taken at Broadbottom.

The Three-spined Stickleback is not confined to comparatively clear streams or other waters; we have examined a number which were captured in the Manchester Ship Canal, on the Lancashire side of the border, where the water is entirely supplied from the polluted Irwell.

TEN-SPINED STICKLEBACK.

Gasterosteus pungitius, Linné.

Local names—Jack Sharp; Stickleback; Tinker.

Abundant and well distributed, but not so common as the Three-spined species.

The distribution of the Ten-spined Stickleback is very similar to that of the last species, but it is not nearly so abundant. I can find no record of its occurrence in marine waters, though such a habitat has been ascribed to the species in North Lancashire. It occurs in both streams and ponds.

On August 26th, 1908, Coward took a Ten-spined Stickleback from a stream in Marbury Park, Northwich, which had no ventral fins and had rudimentary and separate pubic plates. It was apparently similar to the variety described by Day.* The specimen was examined by Mr. R. Elmhirst of Millport.

FIFTEEN-SPINED STICKLEBACK.

Gasterosteus spinachia, Linné.

Occurs sparingly in local waters.

Byerley recorded the Fifteen-spined Stickleback from pools amongst rocks at Hilbre and from Caldy Blacks, but since his date there is only one record for the fish in the Dee Estuary. An example, now in the Grosvenor Museum, Chester, was captured between Flint and Connah's Quay, on October 18th, 1909. In the same collection there is an example which was taken in the Mersey in 1883 by Mr. R. Newstead, and another local specimen is preserved in the Warrington Museum ; it was captured by J. Peers, an enthusiastic local collector, some thirty or forty years ago, probably in the Mersey, but the date and locality have not been preserved.

LAMPRIDIDAE.

OPAH. *Lampris pelagicus* (Gunner).

A rare and accidental visitor to Cheshire waters.

The Opah has occurred only once or twice in local waters. Byerley states that a specimen was caught in the Dee in

* *Linn. Soc. Jnl.* (Zoology), Vol. XIII., 1878, pp. 110–114.

1839 by a Hoylake fisherman. The appearance and size of the fish are such that it cannot be mistaken for any other species, but it is entirely alien and does not really belong to the fauna of the Irish Sea. It occasionally may be seen in local fishmongers' shop-windows on exhibition, but in such cases the specimen has been landed by steam trawlers after being taken outside Liverpool Bay. It inhabits deep water and its occurrence in shallow seas may be due to some exceptional weather conditions or simply to caprice. It is a voracious fish, and when caught near the coast is usually found to be feeding on cephalopods. Mr. T. Scott records finding fifty-four pairs of the horny jaws of these animals in the stomach of an Opah.*

ESOCIDAE.

Sub-order *HAPLOMI.*

PIKE. *Esox lucius*, Linné.

Generally distributed in fresh waters throughout the county.

The Pike is found in all parts of Cheshire. It occurs in the rivers Dee, Dane, Bollin, Weaver, and doubtless in others. Small "Jack," as young Pike are called, are to be found in the ponds, and large fish inhabit the meres. Pennant recorded it from the Mersey in 1801.† Pike are netted in the rivers and meres mainly because they are destructive to the Salmon, Trout or other fish; this is notably the case in the Dee above Chester. They are, however, also caught for the market. The usual means of capture is the "strike-net," an instrument which is really a gill-net. It is a long straight wall of netting which is buoyed and weighted so as to stand

* *Fishy. Bd. Scotland, Twenty-First Ann. Rept.*, 1902, Pt. 3, p. 219.

† *Tour from Downing to Alston Moor*, p. 16.

vertically in the water, and fish striking against it are meshed just behind the gills. Usually it is worked about the beginning of March, when the fish are visiting the reeds for the purpose of spawning. Mr. J. Hindley's records of fish taken in this manner at Marbury Mere near Northwich give sixteen, eighteen and twenty-two pounds as the weights of the heaviest fish caught. Coward watched a large spawning Pike at Oulton Pool on March 27th, 1907. It repeatedly attempted to enter the reeds and other waterside vegetation, but was every time repulsed by the attentions of smaller and probably male Pike, which pressed against its side with their snouts. Whether this was an amatory caress to assist in the expulsion of the ova, or was intended to warn the intruder from a particular spot already occupied by a female, for the Pike is said by Day to be monogamous, it in every instance had the effect of driving away the larger fish.

Pike stories are nearly as numerous as dog anecdotes; I select two of the more credible local ones. At Alderley Park one was seen "lashing his tail out of water" in a pool. When taken from the water it was found to have captured another Pike, the head of the captive being fixed in its mouth, so that the snout protruded from its gills. Both fish "seemed nearly exhausted with their exertions."* It is, of course, true that any soft object which gets into a living Pike's mouth is bound to go further in, for the action of the hinged teeth is such as to drag any object which moves or struggles into the mouth. The late Dr. Thomas Warwick found a Pike in a pool in Dunham Park with its head injured, the result of the fish having dashed against a tenterhook. He picked up the fish and by a slight operation replaced the damaged bone. The fish recovered and was released, but it became quite tame and would come to its benefactor when he whistled for it.† The doctor attributed the behaviour of the fish to gratitude, but there

* E. J. Stanley, *Zoologist*, 1845, p. 1035.

† *Field*, VI., 1855, p. 245.

is no doubt that the Pike had been fed for some days whilst its wound was healing, and associated the whistle with the expectation of food. I have seen Cod in captivity come to be fed by hand.

ANGUILLIDAE.

Sub-order *APODES.*

EEL. *Anguilla anguilla* (Linné).

Local name—Snig.

Abundant in Cheshire.

The Common Eel is abundant and widely distributed throughout Cheshire, being found in streams, ponds, meres, and in the tidal waters of the estuaries. I have no record of its capture in strictly marine waters.

Interest in the Eel centres in its migrations to and from the sea. The outlines of the life-history of the fish are now known, largely through the investigations of Schmidt*; there appears to be no doubt that the Eels of Cheshire, in common with those of the rest of the British Isles and the north-west of Europe come to sexual maturity and spawn only after they have migrated into the open Atlantic Ocean. The area where Schmidt found the youngest Eel larvae, or *Leptocephali*, is, roughly speaking, near the five hundred-fathom contour-line, in the sea to the south and west of the Icelandic and British Plateau. The larvae hatched out in these remote waters migrate towards the coasts of north-western Europe, and when near the land undergo the metamorphosis to the transitional larval stage known as

* *Rapports et Procès-verbaux Conseil Permanent Internat. pour l'Explorn. de la Mer*, Vol. V., 1906.

the Elver. The elvers are the "eel-fry" which ascend the rivers during the spring months, being then from two to three inches in length. The ascent of the rivers by the Elvers has been noticed in Cheshire towards the end of April. At the end of that month in 1908 Mr. J. M. St. John Yates found the dam at Buglawton swarming with the little fish. There is no indubitable record of the occurrence of a true leptocephaline stage in the waters of Liverpool Bay.

The downward migration of the Eels from the rivers to the sea begins in May, when a proportion of the fishes is about to enter on the stage of sexual maturity. Smitt states that the descent of the Eels of the Scandinavian rivers begins about May and culminates during the dark nights towards the end of August.* This appears broadly to be true also for the Cheshire rivers, but the earliest date at which the Eels have been observed to "run" is March 19th, while the latest is in December. I quote here some admirable observations of Mr. J. Hindley, gamekeeper at Marbury near Northwich; they refer to the dates at which Eels were observed running from Marbury Mere, a typical Cheshire eel-water:—

1895—November.
1896—September and October.
1897—September, October and November.
1898—April 13th, May, November.
1899—April 10th, October, November.
1900—August.
1901—November.
1902—March 19th, May, September, October.
1905—November.
1906—December.

On April 29th, 1908, Coward saw over half a hundredweight which had been caught in the exit stream from Marbury Mere. The majority varied in weight from half

* *History of Scandinavian Fishes*, Pt. II., p. 1031.

to three-quarters of a pound, but some were over one pound; occasionally they are taken up to five pounds in weight. Mr. Hindley informs me that the usual custom is to set the traps about the end of April, and from that date onwards the Eels run whenever there are rains; the largest catches are usually made about the beginning of October. Two Eels which I examined from this locality in May, 1908, were probably not fish which were close upon the assumption of sexual maturity, being dull lead coloured, except on the bellies, which were white, not silvery. Two larger Eels were sent to me by Mr. Hindley in December, 1909. In these fish the belly was more distinctly silvery, and they appeared to have all the characters of Eels which are migrating to the sea when about to become sexually mature. One of these fish was alive and was put into a freshwater tank and kept under observation. On February 20th, 1910, the pigmentation was much more uniform, all the skin, with the exception of a narrow patch beneath the head and on the abdomen, being of a dull smoky tint. It refused food during confinement but increased in size. It made frequent attempts to leave the tank, and during the Christmas vacation succeeded in doing so, being found three days after its escape on the floor in a dark corner, no worse for its prolonged absence from the water. I think it is probable that the Eels which begin to run from this mere in April are fish which are simply beginning their seaward migration, but that they do not actually reach the sea until the autumn. The running of the Eels at Marbury Mere occurs after floods, and the fish reach the sea *viâ* the exit stream from the mere and the river Weaver. According to Mr. Hindley's observations, the running of the fish, while occurring very often on dark nights, is not necessarily restricted to such occasions. Their migration paths in the sea are not known, for there is no regular estuarine Eel fishery in Cheshire, such as exists in the Baltic; I know of no record of a freshwater Eel being taken in a shrimp trawl.

MARBURY MERE NEAR NORTHWICH.

CONGER. *Conger conger* (Linné).

Widely distributed and fairly abundant in Liverpool Bay.

The Conger is found all along the Cheshire coast both close inshore and out at sea. It is an almost ubiquitous fish. It exhibits a preference for rough and stony grounds, liking to shelter itself beneath stones, where it may be found at low water. Nevertheless I have often trawled it from quite flat sandy sea bottoms in Liverpool Bay. The Conger in local waters never attains sexual maturity; its life-history resembles that of the Common Eel in that it migrates into deep water when about to enter on the phase of sexual maturity. Congers with ripe reproductive organs are never found in shallow water, and local specimens which have been kept in aquaria always die before they are in a condition to spawn. The spawning grounds appear to be similar in position to those of the Eel. The *Leptocephalus* larva of the Conger resembles that of the Eel, but is larger. It has been recorded by Mr. A. Scott from the mouth of the Mersey off New Brighton,* and by Herdman and Dawson from the Dee, but I think it is very doubtful whether these records relate to the typical leptocephaline stage of the Conger. They are probably records of the "hemilarval" stage, that is the transitional stage between the *Leptocephalus* and the elver. Captures of the true *Leptocephalus* on the British coasts are very few in number; the only one in recent years on the west coast is that recorded by Mr. A. Scott, when a typical *Leptocephalus* was taken on the sands at the entrance to Barrow Channel.† It is probable that although the larva may occur on the Cheshire coasts, the captures of "Leptocephali" recorded above really relate to stages a little older than the true larval form.

* *Lancashire Sea-Fish. Laby. Ann. Rept.* for 1898, p. 18.

† *Op. cit.* for 1906, p. 91.

CYPRINIDAE.

Sub-order *OSTARIOPHYSI.*

LOACH. *Cobitis barbatula*, Linné.

Local name—TOMMY LOACH.

Common and widely distributed in Cheshire.

The Loach is found throughout Cheshire in almost every stream with shingle bottom. It is one of the most widely distributed of the cyprinoid fishes. It occurs in at any rate some of the shallower meres; Mr. F. S. Graves has on several occasions obtained it in Redes Mere.

The Loach is tenacious of life; one captured in Baguley Brook near Timperley by Coward in 1902 was carried home wrapped in grass in a small tin, and when restored to water more than two hours after it had been taken from the stream rapidly recovered its powers. It showed a disposition to leap out of the basin in which it was kept for two or three days, and several times succeeded in doing so, even when the basin was covered with the exception of a space about three inches wide, left to give the fish light and air. This habit of leaping out of an aquarium, or even out of a stream, is referred to by Couch, Newman and Day, and is supposed to be connected with the susceptibility of the fish to atmospheric changes. It is possible that the habit has been acquired in shallow streams, where the Loach might be left during dry weather in small isolated pools. A fish that can under these circumstances spring out of a pool and struggle into running water, being at the same time able to live for a considerable period out of its element, has advantage over one that could not escape from its dangerous imprisonment.

CARP. *Cyprinus carpio,* Linné.

Fairly common in ponds in Cheshire.

The Carp occurs in a number of meres and ponds throughout the county, *e.g.*, at Tabley, Capesthorne, Bowdon, Mobberley, Knutsford, Plumbley, Prestbury and Adlington. Byerley records it from "various streams of the district," but the fish is one of sluggish habits, delighting in quiet waters, in ponds with muddy bottoms and shaded by trees. It has, of course, been introduced into the county.

CRUCIAN CARP. *Cyprinus carassius,* Linné.

Not common in Cheshire.

The Crucian Carp is almost a stranger to Cheshire waters. It has been introduced into a few ponds. Coward found it in a pond near Bowdon, and it occurs near Bromborough.

GOLD FISH. *Cyprinus auratus,* Linné.

Domesticated throughout the county.

The Gold Fish is, of course, a "domestic animal." It is often introduced into pleasure ponds and other waters, and appears to revert to its original greenish colour when kept in the open.

GUDGEON. *Gobio gobio* (Linné).

Fairly common in rivers and canals.

The Gudgeon is widely distributed throughout Cheshire. It occurs in the Dee, Dane, Bollin and other streams, and in the Bridgewater, Peak Forest and other canals.

TENCH. *Tinca tinca* (Linné).

Common throughout the county.

The Tench is generally distributed throughout the county in rivers, streams, ponds, meres and marl-pits. Byerley regarded it as common in the Weaver, and I have records of the occurrence of the fish at Tabley, Knutsford, Mobberley, Northwich, Redes Mere, and from the Dane. It has probably been introduced into many of the Cheshire waters.

MINNOW. *Phoxinus aphya* (Linné).

Rather rare in Cheshire waters.

The Minnow is found in the Dee, Dane, Bollin and Birkin. It has been taken in a few brooks and streams in various parts of Cheshire, among them Arley Brook and Peover Eye. Byerley doubted its occurrence in Cheshire waters. It is certainly not abundant.

DACE. *Leuciscus grislagine* (Linné).

Local names—GRAINING ; SHOALER ; SHOULDER.

Common in Cheshire streams.

The typical Dace exists in many streams throughout the county—the rivers Dee, Dane, Bollin and Weaver, Cranage Brook and doubtless others. It is said to occur in some ponds. Local fishermen speak of two varieties, the typical Dace and the Graining, and regard them as distinct. The Graining is *Leuciscus lancastriensis*, Shaw, also referred to

as a separate species by Pennant and Yarrell, the former of whom found it in the Mersey near Warrington. There is no doubt that these two forms are simply local colour varieties of the typical Dace, for there does not appear to be any essential difference between the fishes described by anglers as Graining and those regarded as the typical Dace; modern ichthyologists regard Shaw's *L. lancastriensis* as only a synonym of *L. grislagine.*

CHUB. *Leuciscus cephalus* (Linné).

Common in Cheshire waters.

The Chub is fairly common in many brooks and streams. It was recorded from the Mersey by Pennant in 1801.* Byerley gives the Weaver as a locality on the authority of Nicholas Cooke; and it also occurs in the Bollin, Dane, Cranage Brook and White Lodge Brook, Tabley.†

ROACH. *Leuciscus rutilus* (Linné).

Local names—Dace; Roach Dace.

Common and widely distributed throughout Cheshire.

The Roach is one of the most abundant Cheshire fresh-water fishes; it is found in rivers, meres and ponds throughout the county. Mr. Robert Newstead informs me that it sometimes occurs in the tidal waters of the Dee below the Chester Weir. The fish sometimes attains a comparatively large size; Mr. Guy told Mr. R. Newstead that Roach weighing from two to three pounds are occa-

* *Tour from Downing to Alston Moor*, p. 16.

† De Tabley, *MS. note-book.*

sionally taken in the lake at Bolesworth Castle. It spawns in the late spring and early summer; Mr. J. Hindley informs me that he saw it spawning at Marbury Mere near Northwich on May 12th, 1896, May 22nd, 1897, and May 11th and 12th, 1898.

RUDD. *Scardinius erythrophthalmus* (Linné).

Not common in Cheshire waters.

The Rudd occurs in some ponds and meres, but its distribution is not general. It is found about Bollington near Macclesfield, and I have records from Oulton Pool* and from a pond at Christleton.† Coward tells me that it occurs in ponds near Bowdon, and in others at Gayton near Heswall.

BREAM. *Abramis brama* (Linné).

Local name—Carp Bream.

Abundant in rivers, large lakes and ponds.

The Bream is the most abundant freshwater fish in the larger Cheshire waters. It occurs in the Dee, Weaver and Dane, and abounds in the meres. It is the favourite "coarse fish" of the anglers, and many Lancashire fishermen make it the object of week-end visits to the Dee.

The Bream is a constant prey of the Heron. In hot weather it swims at the surface of the meres with the tip of the caudal fin just above the water, and is then easily secured by the bird. The skeletons of large fish of two

* De Tabley, *MS. note-book.*

† R. Newstead, *in lit.*

WILTON BROOK, A "FLASH" AT NORTHWICH.

*[142]

pounds in weight or over, picked clean by the Herons, are often to be seen on the banks of the meres. The fish is also destroyed by the Otter.

The Bream spawns in the early summer. Mr. J. Hindley's notes give June 4th, 1896, and May 22nd to June 10th in 1897, for the spawning times at Marbury Mere near Northwich. Coward says :—"On April 9th to 14th, 1902, a brook at Marbury, about ten yards or more from where it enters the mere, was full of young Bream. They were very much bluer and more silvery than adult fish. The radial formula was D 11, A 28–29, P 16, V 19, C 17–18. The depression in the nape of the neck was not so marked as in the case of adult Bream ; and the lower jaw was proportionately shorter."

Bream in Cheshire waters are often infested with a large tapeworm.

SALMONIDAE.

Sub-order *MALACOPTERYGII.*

SALMON. *Salmo salar,* Linné.

Common in the Dee and its tributaries ; occasionally enters the Mersey Estuary.

The Salmon still occurs in some abundance in the Dee, both estuary and river, though, if past records are to be believed, the glory of this area has departed. Legislation, so often invoked on behalf of the Salmon and the sportsman, has not availed against the forces of modern commercialism and the ineptitude of modern sanitary authorities. The same thing has occurred in the Dee as in most of the other salmon-rivers of England ; increasing pollution of the water has acted prejudicially to the maintenance of a large stock of the fish.

I think there is little doubt that Salmon were formerly more abundant in the Dee than at the present time. But it is very difficult to be sure of any conclusions that may be made as to the comparative abundance of the fish now and at a period of say a hundred years ago. Fishery statistics are things of comparatively recent date, and even at the present time they are very imperfect. We are compelled therefore to form estimates of the relative value of the river from data which may easily be misleading. *Domesday Book* informs us that the fishery at Eaton gave employment to six persons, and yielded a thousand Salmon annually. In 1289 the Chester fishery was valued at £20 annually (in the money values of the period). Ormerod states that Salmon were once so plentiful at Chester that clauses were inserted in the indentures of apprentices guarding against the too frequent occurrence of this fish in their diet. But this fascinating statement has been made with reference to almost every salmon-river in Great Britain, and is almost certainly mythical.* By the end of the eighteenth century we hear of deterioration in the fishery, for in that year a " Society for the Preservation of the Salmon Fishery " was instituted at Chester ; and from time to time during the nineteenth century there are statements in the literature of the county recording the decadence of the fishery. But even now the fishery is one of some importance. There are forty-five draught salmon-nets working in the Dee, and an annual licence of £5 is paid for the privilege of using one of these engines. There are also four coracle-nets, with a licence fee of £2 5s. each ; five trammel-nets, for each of which a fee of £15 per annum is paid, and ninety-seven rods which bring in total fees of about £72.† These figures indicate that the Dee still yields a considerable number of Salmon annually, but just how many we do not know ; the acquisition of this most important information

* T. N. Brushfield, " The Salmon Clause in the Indentures of Apprentices," *Journ. Chester Archaeological Soc.*, Vol. 6, N.S., Pt. I., 1897, p. 5.

† *Salmon and Freshwater Fisheries Acts*, Ann. Rept., 1906, pp. 10, 11.

is apparently a matter which is too difficult for the Central Fishery Authority or the local Board of Conservators. The reports of the Central Authority tell us that the Salmon fishing in the river was "above the average," "about the average" or "below the average"—unilluminating statements which I quote under protest. If then the present information regarding the fishery is so imperfect, it is difficult to attach much importance to any statements as to the yield of the district in former times.

There can be little doubt that the fishery has deteriorated, and that the deterioration is due to the increasing pollution of the river, which has acted prejudicially on the migrations of the fish. The contamination of the Dee is not nearly so serious as that of some rivers in Lancashire, the Lune for instance, but it is fairly evident. This pollution is "not so serious as actually to prevent the passage of fish (but it is) sufficient seriously to impede it at least during the summer and autumn."* The pollution of the Dee is due both to domestic sewage and manufacturing effluents. The river and estuary receive the sewage from a population of about two hundred thousand persons, the principal contributing communities being Chester, Wrexham, Llangollen, Holt, Farndon, Corwen and Bala. They also receive the refuse from chemical works, ironworks, galvanizing works, tar and manure works and paper mills. The enterprises which have acquired distinction in the fouling of the river are chiefly the Chester Sewage Works, where the sewage appears to be treated by the obsolete method of precipitation by chemical reagents, the Cefn Ironworks, Summers's Ironworks, and the North Wales Paper Mills. There are, of course, many others.†

Salmon are caught above Chester Weir by rods only; the best reach of river for rod fishing is said to extend for eight to ten miles below Llangollen. The area under the

* *Report of the Commissioners on Salmon Fisheries*, p. 43 (Cd. 1188), 1902

† *Id., Minutes of Evidence* (Cd. 1269), 1902. Questions 8986 to 8988, p. 282.

jurisdiction of the Dee Board of Conservators extends to the Point of Air on the west, and along the Wirral coast to the Coastguard Station at New Brighton. No Salmon are, however, taken on the northern coast ; and netting is practically confined to the estuary above Dawpool and Holywell. Sometimes nets are employed on Salisbury Bank, but there is not much fishing there. Three kinds of nets are used :—(1) The coracle-net, which must not exceed sixteen yards in length. The coracle is a small, roughly quadrangular boat, a framework of wood, on which is stretched a tarpaulin covering. Two of these antiquated craft are employed, and the net is stretched between them. The boats drift down the stream in the hope that a fish will strike the net ; when this happens they close up so as to encircle the fish. (2) The draught-net, really a seine-net with a bay in the centre, must not exceed two hundred yards in length nor eight feet in depth, and the meshes must not measure less than two inches from knot to knot. One end of the head rope is kept on shore, and the rest of the rope and net are stowed away in the stern of a rowing boat, which is then pulled out from the bank, taking a semicircular course, the rope and net being paid out meanwhile. When the boat reaches the shore again, the other end of the head rope is cast ashore and the net is hauled. (3) The trammel, a net which is used all round the shores of Britain, is a triple wall of netting, the median net being composed of a fabric which has meshes of two and a half inches from knot to knot, while each of the two external nets has meshes of eleven inches from knot to knot. The whole must not exceed a hundred yards in length. One end of the head rope is buoyed, and the other is attached to a boat, so that the whole contrivance floats through the water as an upright wall of netting. When a fish strikes, it passes through the wide meshes of the anterior net, but is meshed behind the gills in the median narrow net, which is then forced through the posterior external net, so that the fish is entangled or trammelled

in a pocket. Sometimes the water is beaten with the blade of an oar, so as to alarm the fish and cause them to dart against the net; this is called "fluing."

Trammels are not allowed *above* a line from Burton Point on the north to Rockcliff Hall on the south; and two trammels must not be nearer each other than three hundred yards. No net of any kind may be used between sunset and sunrise *above* the line mentioned, and there is a weekly close time from midnight of Friday to midnight of Sunday. The annual close season for nets is from September 1st to March 31st, and for rods from November 2nd to March 31st.

The Dee Salmon present no special peculiarities. In 1891–92 the Board of Conservators erected a small Salmon hatchery and began the artificial culture of the fish. Some three or four years later an apparently new stock of Salmon was observed to be present in the river. These fish differed distinctly from those usually present, and were regarded by the late John Simpson, the Superintendent, as derived from the introduced fry.* This is probable, since recent investigations in other districts prove that the Salmon generally returns to the river in which it was spawned. Unfortunately the Board was compelled by lack of funds to discontinue hatching operations.

The rod fishing is best in the autumn. The grilse go up the river about the end of June and in July, but the best run of fish appears to be in the autumn. Chester Weir presents a decided impediment to the passage of the fish from the estuary, and this defect has so often been commented upon by Salmon authorities that one wonders why it has not long ago been remedied. Ordinary flood tides do not overtop the weir, and only a sixteen feet spring can do so. Running Salmon may therefore become "neaped" in the pool below, where they receive the benefit of the pollution provided for them by the City Sanitary Authority. There is apparently plenty of spawning ground

* *Report of the Comm. on Salmon Fisheries*, 1903, Question 9118.

in the upper reaches of the river and its tributaries—eighty-two miles in all—but much of this ground suffers pollution by sewage, which permeates the gravel beds and operates prejudicially, without doubt, on the developing eggs in the redds. It is hardly likely that the pollution of the lower reaches of the river is a very serious danger to the descending smolts. Considerable destruction of the latter is, however, said to be effected by the Pike, which are rather abundant in a reach of the river about ten to twelve miles above Chester. The Pike spawn among the weeds just about the time when the smolts are coming down stream. Many of them are said also to be destroyed by ducks.*

The Salmon of the Mersey are to be compared with the snakes of Ireland—there are none there! Yet there are many historical references to the presence of Salmon in "Liverpool River." William Smith, writing in 1656,† speaks of the "great store of salmons" yielded by the Mersey, and Aikin says, in 1795,‡ that "Salmon are brought in plenty from the rivers Mersey and Ribble into Manchester Market." In 1813 Salmon must have existed in the Mersey in fair abundance, for the Vicar of Eastham had a right to all the fish caught on Fridays and Sundays.§ He ought to have commuted his rights then! It is said that, thirty or forty years ago, Salmon were often seen at Runcorn, and in 1894 an unfortunate fish was taken in a lock of the Ship Canal.‖ Even within recent years Salmon have attempted to ascend the river; in June, 1908, some were seen in the estuary, and one was taken in the river just below Warrington Bridge a few days before the capture of a Grey Seal,¶ which had, no doubt, followed the

* *Salmon Fisheries*, Rept. of Commissioners, 1902, Pt. ii., Cd. 1269. Question 8947.

† King's *Vale-Royall*, p. 22.

‡ "Description of the Country from thirty to forty Miles round Manchester," p. 205.

§ Daniel, *Rural Sports*, Supplement, p. 178.

‖ *Manchester Guardian*, June 23rd, 1894.

¶ *ante*, Vol. I., p. 45.

Salmon up the river. The construction of the Manchester Ship Canal, the ever increasing fouling of the tributaries of the Mersey, and the pollution of the river itself by the sewage of the Liverpool area have effectively banished the Salmon. Long ago there must have been indications of this, for there is no Board of Salmon Conservators between the Ribble and the Dee—nothing being there to conserve. Some years ago an elderly woman at Romiley told Coward that she remembered her father taking a big Salmon from a pool in the Goyt, but perhaps the last recorded instance of a Salmon being caught in a tributary of the Mersey is given in the late Lord de Tabley's MS. note-book: "Samlet: My father (the second Lord de Tabley) took one with a fly in Peover Brook at the mill, in 1847."

TROUT. *Salmo trutta*, Linné.

Local names (Sea Trout)—SALMON TROUT; BUNTLING; FORKTAIL.

The Sea Trout occurs in the estuaries, though not commonly. The Brook Trout is abundant in the inland waters.

If we disregard the colour markings, the Brook Trout, Sea Trout and Salmon Trout are to be referred to one species—*Salmo trutta.* I do not think this is a conclusion with which most anglers will agree, for the non-essential differences between these various fishes are very striking. This, however, is hardly the place to discuss the systematic value of the numerous varieties of trout and sea trout, but the opinion of most of the leading ichthyologists may be adopted here. The Brook Trout is found generally all over Cheshire. It is abundant in the Dee and its tributaries, as well as in other streams. In the Dee it is most abundant in the upper reaches. It is fairly plentiful in the hill streams in the east of the county, for instance, the moorland

streams near the Derbyshire border. It has disappeared from some streams, such as Crowden and Heyden Brooks, since the formation of the Manchester Waterworks in Longdendale. Restocking has been carried out extensively in the streams on the Cheshire plain, Loch Leven and Rainbow Trout being planted there. Brook Trout are occasionally taken in the estuary of the Dee in tidal waters. The fish now seldom occurs in the Mersey, though Pennant found it there in 1801.* In June, 1908, however, some were taken at Latchford Locks on the Ship Canal. The annual close time for Brook Trout in the Dee is from October 14th to February 14th.

The Sea Trout is taken by the Salmon fishers in the Dee, but it is evident that it is far less abundant than formerly, probably because the fish is more intimately associated with the fresh waters than is the Salmon, and has therefore suffered to a greater extent from the pollution of the streams. It appears to have been common in the Mersey and Weaver in former times,† but the pollution of these streams by the alkali works must have rendered them uninhabitable for the Sea Trout long ago. The fish is still taken at the Weir at Chester.

GRAYLING. *Thymallus thymallus* (Linné).

Not uncommon in various Cheshire streams.

The Grayling was perhaps more abundant in the county formerly than it is at the present time ; Byerley, for instance, refers to this fish as abundant in the Dee. It occurs locally now in the Dee, Gowy, Bollin, Birkin and other streams. In some of the waters where it is now found it has probably been introduced.

* *Tour from Downing to Alston Moor*, p. 16.

† Rev. E. A. Pitcairn Campbell, *Decline of the Salmon Fishery in the River Dee*, p. 5.

SMELT. *Osmerus eperlanus* (Linné).

Local name—SPARLING.

Rather rare in the sea and in the tidal waters in the estuaries. Acclimatised in Rostherne Mere.

All references in the literature point to the former abundance of the Smelt in local waters. Leigh, in 1700, says that "vast quantities of Sparlings or Smelts" were taken in the Mersey,* and Byerley, in 1854, refers to the fish as common. In 1879 it was apparently absent from, or at least very scarce in, the Mersey. "The Mersey used to be famous for Smelts. They were all got near Warrington. Some were got below Runcorn. There are no Smelts caught now in any part of the Mersey."† Pennant, in the eighteenth century, found it abundant in the Dee, where there was a regular fishery.‡ Mr. A. O. Walker, in 1893, refers to it as almost extinct in the Dee.§ It still occurs at the mouth of the Mersey near the Formby shore. It is essentially an estuarine species, gregarious when it ascends brackish or waters of low salinity in the winter or spring, and is apparently solitary in the open sea. Perhaps we may attribute the desertion of the estuaries to their pollution.

At the present time the Smelt is fairly abundant in Rostherne Mere, where Day says it was introduced by "Mr. Egerton."‖ There does not, however, appear to be any record of the introduction of the fish, and it certainly was in the mere in the first half of the eighteenth century, for Richard Brookes, writing in 1740, refers to it. He calls the fish "the Sprat or Sparling," and says that it is the young of the Herring, but it is evident that, although he

* *Natural History of Lancashire, Cheshire, etc.*, Book I., p. 140.

† *Report by Frank Buckland and Spencer Walpole on the Sea Fisheries of England and Wales* (Cd. 2449), 1879, p. 93.

‡ *British Zoology*, III., 417.

§ *Liverpool Biol. Soc., Transactions*, Vol. VII., 1893, p. 3.

‖ *British Fishes*, Vol. II., p. 123.

confuses the species, he here means *Osmerus eperlanus*. The following is his account: "In *Rotherston*, or *Rostern-Meer* in *Cheshire*, there are *Sprats* taken annually for ten Days about *Easter*, which are not to be distinguish'd in any manner from *Sea-Sprats*, being of the same Colour, Shape and Taste. Likewise at the same time that they are taken in the *Meer*, they are also caught in the River *Mersey* below *Warrington-Bridge*, where the Tide brings up the Salt-Water, which Place is about seven or eight Miles from the *Meer*. But the most remarkable Circumstance relating to the Affair is this, That tho' there is a Rivulet runs thro' the *Meer* into the River *Mersey*, and though there are several *Weirs* between the Lake and the River, yet no *Sprats* have been ever caught or seen between those two Places; therefore the Question is, how they can get out of the River into the Lake? If they do come from thence it must be by means of a Flood, and even then they must reject two or three other Rivers that run into the *Mersey* for the sake of this Lake; for there are no *Sprats* found in the *Bullen* or *Berken*, which are join'd by the Rivulet that runs thro' the *Meer* before they reach the *Mersey*. There is, indeed, a parallel Instance in the same Neighbourhood in favour of this Opinion, there being two Rivers, the *Weever* and the *Dane*, which meet at *Northwich*, and yet *Salmon*, when they come out of the Sea, always enter the *Dane*, and never visit the *Weever*. But tho' this is allow'd to be the Case of the *Sprats*, yet what Reason can be assign'd that none are ever taken at the Weirs, since they must necessarily pass thro' them once a Year? Some, who are aware of this Difficulty, suppose they were first carry'd into the Lake by an extraordinary Inundation, and have bred there ever since, only, like the *Char*, making their Appearance at the Time of Spawning."*

Mr. A. Carter† is of opinion that the Smelts did originally enter the mere by ascending the Bollin, Birkin and

* *Art of Angling*, pp. 153, 154.

† *Fishing Gazette*, August 15th, 1908.

ROSTHERNE MERE.

Blackburn's Brook, and states that the weir at Bollington flour-mill would be the only obstacle, and that it was often in a state of disrepair. The pollution at the mouth of the Bollin would not, in the early part of the eighteenth century, be sufficient to stop the fish. Brookes, however, speaks of more than one weir, and there are altogether three at the present time; if the fish ascended from the tidal Mersey it was probably before the days of flour-mills and weirs.

Rostherne Mere is generally supposed to be in a hollow caused by subsidence over salt deposits, and some people, doubting that the fish could live permanently in fresh water, have suggested that the water at the bottom of the mere is salt. This view was advocated by Professor Boyd Dawkins, who thought it possible that the Smelts really inhabited an under stratum of dense water. This is possible, though it is difficult to account for the non-diffusion of the salt throughout the whole body of the water in the mere, unless salt is being continually dissolved from bottom deposits, and as continually drained off as a very dilute solution. Until the chemistry of the bottom waters has been investigated it is impossible to settle the question. There is, of course, no difficulty in supposing that a marine fish can be accustomed to live in fresh water, and there are well authenticated cases of introduced Smelts becoming properly naturalised.*

At times large numbers of the Smelts are netted in the mere; and occasionally when it is frozen the fish are crowded together in patches of open water, or even embedded in the ice. The Rostherne Smelts are small, owing, no doubt, to retardation of growth induced by complete isolation from the sea. Examples submitted by Coward to Dr. Günther did not appear to differ in any essential character from typically anadromous examples of the species.

* *Cf.* Day, *British Fishes*, II., p. 123.

CLUPEDIAE.

ANCHOVY. *Stolephorus encrasicolus* (Linné).

A rare visitor to Cheshire waters.

The Anchovy is a "south fish" which only visits Cheshire waters at rare intervals, and then always in small numbers, not being gregarious here as in more southerly latitudes. It has been recorded many times from the Mersey and Dee area. In 1669 Ray obtained it, for the first time in British waters, from the estuary of the Dee*; and Pennant† and Byerley recorded it from the same estuary. I have found it several times in the catches made by shrimp trawls working off the estuary of the Mersey, but never more than one or two in a single catch.

Probably the Anchovy spawns in Liverpool Bay, in spite of its scarcity. Its eggs are pelagic, and were found for the first time in British waters in the estuary of the Ribble by the late R. L. Ascroft.

HERRING. *Clupea harengus*, Linné.

A migratory gregarious fish, at times abundant in Liverpool Bay.

The Herring is one of the species which appear at times in a sea area in great abundance and then, for some reason not understood, desert it for an indefinite period. It migrates into the Cheshire sea area during the winter, though summer Herrings are also found and examples may be taken at any season. As a rule mature Herring are not abundant at the present day, though great numbers

* *Philosophical Letters*, p. 47.

† *History of the Parishes of Whiteford and Holywell*, p. 151.

of immature fishes are at times taken, especially during the warmer months. The Herring is caught in the stake-nets and also occasionally in the trawl-nets. Drift-netting is not now systematically practised in our area.

Herrings are far less abundant now in local waters than they appear to have been at certain times during the past two centuries. Pennant, writing of his tour in 1773, says: "The herring in this sea is extremely desultory. At times they appear in vast shoals, even as high as *Chester*; arrive in the month of *November*, and continue till *February*: and are followed by multitudes of small vessels, which enliven the channel. Great quantities are taken and salted: but they are generally shotten and meagre. It is now about ten years since they paid us a visit."* T. J. Moore gives a later record of Herring shoals in the Mersey. He says, writing in 1871, that so late as 1838 and 1840 "large numbers were taken off Egremont and New Brighton, but now they are not met with nearer than the Isle of Man."†

Herring shoals last appeared in the Mersey in 1891. In that year the Morecambe fishing-fleet, with some boats from Annan, had been working off Jumbo Buoy near the estuary of the Ribble, and from there down towards Burbo Bank and the Rock Channel, getting good catches of Herring. Hearing that some local shrimpers were taking Herrings in their trawl-nets in the Mersey, they tried there and found the shoals. "That winter the Mersey was alive with Herring." The fishermen shot their nets off the Powder Magazine and drifted up past Garston and Port Sunlight to the Manchester Ship Canal. The catches ranged from three thousand to about twelve thousand fish per tide.‡

It is clear that the Herring shoals visit the Mersey area at intervals, but the history of the fishery is too incomplete to enable us to say whether these visits are periodic or

* *A Tour in Wales*, 1784, Vol. I., p. 21.

† *Liverpool Naturalists' Field Club, Proc.*, 1871, p. 41.

‡ This account was given to me by Mr. Edward Gardner, Fishery Officer at Morecambe.

sporadic. Fishermen, when they speak of the present scarcity in local waters, usually ascribe it to the steamboat traffic, which they think frightens the Herring away. But this can hardly be true, for the Mersey was a busy river in 1891.

There is no evidence that the Herring spawns in Liverpool Bay. The fish produces demersal eggs, laid on stones, shells and weed, to which they adhere. I have seen spawn said to be that of the fish, but several other species deposit similar eggs, and none that I have seen can be ascribed with certainty to the Herring. It is, however, probable that the Herring spawns somewhere in the neighbourhood of Liverpool Bay, for the young are at times very abundant. Among the fish known locally as "Sprats" there are quantities of young Herring.

SPRAT. *Clupea sprattus*, Linné.

Local name—SHAD.

Generally very abundant in local waters.

The little fishes called "Sprats" by the fishermen are nearly always a mixture of Herrings and Sprats. Usually the latter species predominates, but the proportions vary very much. At times these fishes are extremely abundant in the sea just off the estuaries; I have seen a catch of many thousands of Sprats and Herrings made in a single haul of a shrimp trawl. As a rule, however, the trawl only contains a few examples. The Sprat is a pelagic fish, and does not usually inhabit the sea bottom; when a trawl-net catches large numbers of these fishes it is possible that they were caught while the net was being "shot," or descending towards the sea bottom.

Sprats and young Herrings often ascend the estuaries for some distance and will even enter fresh water. In the Dee

large numbers of them are left by the receding tide in the pools on the marsh, even on the landward side of the Burton Cop. The fish die in the shallowing pools whilst they are still covered by an inch or two of water, and are attacked and devoured by crustaceans and birds. In November, 1909, a large shoal entered the Manchester Ship Canal and, accompanied by a big flock of gulls, ascended so far as Latchford Locks above Warrington. Mr. H. Congreve, who saw the fish in great numbers in the locks on the 28th, says that they varied from one to six inches in length, and that they were killed by the fresh or polluted water. The specimens which he obtained for Coward were Sprats, but it is practically certain that the shoal included young Herrings.

Unlike the Herring, the Sprat produces pelagic eggs; these have been taken among the plankton collected in Liverpool Bay during the months April to June.

A large catch of Sprats taken in Liverpool Bay generally includes a few fish which harbour the extraordinary parasite *Lernaeenicus sprattae* (Sowerby). This is a copepod which lives with its suctorial mouth and anchor-hooks firmly embedded in the cornea of the eye of the Sprat. The parasite may sometimes be as long as the host.

TWAITE SHAD. *Clupea finta*, Cuvier.

Local names—SHAD; KING OF THE HERRINGS.*

A migratory fish, very rare in local waters.

The Twaite Shad is a very rare fish in local waters; I have never seen a specimen which was caught in Liverpool Bay. It is, however, recorded by Mr. A. O. Walker as occurring "sometimes in the Dee"; and by T. J. Moore from the Mersey in 1876, and from the Formby shore.†

* This name is generally applied to *Chimaera monstrosa*, Linné.

† Herdman and Dawson, p. 61.

STOMIATIDAE.

PEARLSIDES. *Maurolicus mülleri* (Gmelin).

A rare visitor to Liverpool Bay.

The Pearlsides was first recorded as the "Sheppy Argentine" by Pennant in 1796. "It was taken near Downing on the Flintshire side of the estuary in 1769."* T. J. Moore† obtained it from the Cheshire shore near Bromborough Pool. It is certainly very rare.

CHONDROSTEI *ACIPENSERIDAE.*

STURGEON. *Acipenser sturio,* Linné.

A rare visitor to Cheshire waters.

The Sturgeon does not often visit Cheshire waters, but from time to time it is captured in the Dee and brought to Chester. Leigh, writing in 1700, speaks of the capture of one twelve feet in length in the Mersey near Warrington.‡ Byerley refers, without details, to captures off the Wirral coast and in the Mersey; and one, seven feet in length, now preserved in the Warrington Museum, was captured in the Mersey about two and a half miles below Warrington in 1851.§ One in the Grosvenor Museum, Chester, was taken in the Dee at Queen's Ferry in 1891, another was caught in the Mersey during the same year, and two were

* *Hist. of the Parishes of Whiteford and Holywell,* p. 151.

† Herdman and Dawson, p. 58.

‡ *Nat. Hist. Lancashire and Cheshire,* Book I., p. 133.

§ W. Fell, *Zoologist,* 1851, p. 3157

obtained from the Dee in 1902.* On August 17th, 1908, a Sturgeon, nine feet three inches in length, was netted at Saltney on the Dee and sold in Chester.

ELASMOBRANCHII.

PLAGIOSTOMI *CARCHARIIDAE.*

Sub-order *SELACHII.*

TOPE. *Galeorhinus galeus* (Linné).

Local names—Dog Fish; Shark.

Rather rare in Cheshire waters.

The Tope, a large dog fish, occurs occasionally in Liverpool Bay, but is much less abundant than either *Scyllium* or *Squalus*. It may be taken almost anywhere, usually on lines or in the trawl-nets, but is never abundant. Pennant recorded it from Flintshire,† and Byerley speaks of it as taken on Cod lines. A Tope, four feet six inches in length, was taken in the Dee near Saltney Bend, and is now in the Grosvenor Museum, Chester. Herdman and Dawson record captures of the Tope from the Mersey above Liverpool, from the Horse Channel and near Liverpool Bar. The Tope was or is still a food fish, and is sold in the Lancashire towns as "Darwen Salmon." It is a viviparous fish which gives birth to about twenty to forty young at a time.

* *Liverpool Mar. Biol. Com., Sixteenth Ann. Rept.*, for 1902–03, p. 41.

† *British Zoology*, III., p. 146, 1812.

SPINACIDAE.

PIKE DOG. *Squalus acanthias* (Linné).

Local names—Blue Dog; Spur Dog.

Common in Liverpool Bay.

The Pike Dog is widely distributed in the inshore waters of the west coast of England. I am inclined to think that the present species is rather less numerous in the Cheshire sea area than *Scyllium canicula*. Both species appear to be gregarious at times, and their relative abundance may vary greatly from time to time. In most specimens of this viviparous fish caught locally and dissected by myself there have been four embryos in each oviduct. The young are born about the middle of the summer, though there is considerable variation in this respect.

LESSER SPOTTED DOG FISH.
Scyllium canicula (Linné).*

Local names—Dog Fish; Spotted Dog; Fay Dog.

Common in Liverpool Bay.

This is one of the most common of the dog fishes in local waters. It is ubiquitous, occurring at all times of the year and almost everywhere along the coast. It is taken both on lines and in the trawl. As a rule not more than a dozen or so are taken at one time in the trawl, but on September 20th, 1904, when trawling near the Liverpool North-west Lightship I saw about four hundred dog fishes, mostly *Scyllium canicula*, taken in one drag of an hour's duration.

* *Scylliorhinus canicula* in the *Scandinavian Fishes*. The generic name *Scyllium* is, however, too familiar to be altered.

They appear to shoal at times. The Spotted Dog Fish is not so numerous in Liverpool Bay as on some other parts of the English coast, where it has at times proved a veritable plague to the fishermen.

LARGER SPOTTED DOG FISH.

Scyllium catulus (Gunner).

Not common in Liverpool Bay.

The Larger Spotted Dog Fish is far less abundant in local waters than any of the other species. I have only seen it on one occasion ; on September 20th, 1904, when a large haul of *Scyllium canicula* was taken near the North-west Lightship, a few *S. catulus* were amongst the smaller fish.

The four dog fishes are voracious creatures, eating almost any other marine animal which they are strong enough to attack. They are a great nuisance to fishermen, for they destroy the fish taken on the lines, especially when in rough weather the lines are left for several days unvisited. Until recently there has been no market for them, except as fish manure, but they are now caught for the fish shops, being sold under some fancy name, such as " flake." I have found the Pike Dog palatable. Certainly a dearth of fish in our seas would lead to the utilisation of these and some other fishes not at present used as human food.

On account of their omnivorous habits all the dog fishes are the hosts of numerous parasites. The commonest of these inhabiting locally caught fishes are the tapeworms *Tetrarhynchus erinaceus* and *T. tetrabothrius*, van Beneden ; *Echeneibothrium variable*, van Beneden, and some other unidentified forms. The parasitic copepods *Echthrogaleus coleoptratus* (Guerin) and *Eudactylina acanthii*, A. Scott, occur on the skin and gills of the Pike Dog, and *Lernaeopoda galei*, Kröyer, on the claspers and fins of the Lesser Spotted Dog Fish. *Lernaeopoda bidiscalis*, W. V. de V. Kane,

is interesting, for it almost invariably occurs on the claspers of the male Tope; these structures are nearly always found to be torn and bleeding from the wounds inflicted by the attachment of the parasite.

RHINIDAE.

MONK. *Rhina squatina* (Linné).

Local names—ABBOT; ANGEL FISH.

Fairly common in Liverpool Bay.

The Monk is generally distributed in the sea off the west coast of England, but it prefers deeper water than is found in the Cheshire sea area. The specimens usually trawled in that part of Liverpool Bay are small and immature, but now and then a large fish is taken. The largest of which I can find any record was taken near the Bell Buoy off Burbo Bank, in 1864. It was four feet eight inches in length.* Moderate sized Monks generally have the copepod *Eudactylina acuta*, van Beneden, attached to the gills.

RAIIDAE.

Sub-order *BATOIDEI.*

SKATE. *Raia batis*, Linné.

Local names—BLUET; BLUE SKATE; DUN.

Common and widely distributed in Liverpool Bay.

The Skate is very widely and generally distributed in local waters, though it is not nearly so abundant as some other

* *Liverpool Lit. and Phil. Soc. Proc.*, Vol. XIX., 1866, p. 11.

members of its genus. The examples taken on the shallow-water Cheshire grounds are nearly always small, immature fish; mature Skate are far from common. The Skate is often taken in the shrimp trawls, in fish trawls and on lines. It is by far the largest member of its sub-order occurring in the Irish Sea, and fishermen usually speak of very large Skate as "Duns."

THORNBACK. *Raia clavata*, Linné.

Local name—RAY.*

Common and widely distributed in Liverpool Bay.

The Thornback is by far the most abundant of the local rays. It occurs at all times of the year and everywhere in the Cheshire sea area, but, as in the case of the last named species, it is only the small and immature fishes that frequent the shallow waters in and off the mouths of the estuaries. Larger and mature Thornbacks are taken offshore towards the Liverpool North-west Lightship. The species reproduces in the sea offshore from our area.

SPOTTED RAY. *Raia maculata*, Montagu.

Local name—RAY.

Common and widely distributed in Liverpool Bay.

The distribution of the Spotted Ray is very similar to that of the Thornback, but it is not so abundant. It spawns in local waters, but not as a rule near the shore. The shallow

* Local fishermen distinguish between "Skate" (or Bluet), "Ray" (*R. clavata* and *maculata*), and "Butterfly" or "Starry" Ray.

waters off the estuaries afford a nursery ground for these two species of ray. They must grow very rapidly in local waters, for a ray when hatched from its purse or egg is quite large enough to be taken by the shrimp trawl. Nevertheless the smallest ray that I have seen caught in a shrimp-net was at least five or six inches in breadth across the pectoral fins.

CUCKOO RAY. *Raia circularis*, Couch.*

Local names—BUTTERFLY RAY; STARRY RAY.

Rare in Liverpool Bay.

The Cuckoo Ray does occasionally occur in the shallow waters of Liverpool Bay, but it is by far the least abundant species of *Raia*. It is rather more abundant offshore in deeper water, but even there it is less common than in the sea off the coasts of South Wales.

TORPEDINIDAE.

TORPEDO. *Torpedo nobiliana*, Bonaparte.

Local name—ELECTRIC RAY.

Very rare in local waters.

The Torpedo does not properly belong to the fauna of Liverpool Bay, and only enters our area at very long

* There is some confusion between *Raia circularis*, Couch, and *R. miraletus*, Couch, and also between *Raia batis*, Linné, and *R. blanda*, Lacépède.

intervals. Byerley states that a specimen was caught by a Hoylake fisherman in the summer of 1853, but it is quite possible that this fish was really captured somewhere to the south or west of the Cheshire area. A record in the stock books of the Liverpool Museum states that a Torpedo was taken off the entrance to the Mersey in 1884* ; Herdman and Dawson also state that one was brought into Liverpool in 1892, but it may have been taken outside our area.

TRYGONIDAE.

STING RAY. *Trygon pastinaca* (Linné).

Very rare in local waters.

Like the Torpedo, the Sting Ray does not belong to the regular fauna of Liverpool Bay ; examples caught locally are casual visitors to our area. There are several old records, and the species is so characteristic that there can hardly be any doubt about their correctness. Byerley states that it has been taken a few times but is rare ; he specially mentions the capture of one near Hilbre Island in 1851. Herdman and Dawson state that the stock books of the Liverpool Museum contain entries recording the captures of Sting Ray in the Rock Channel in 1868 and 1869, and near the Bell Buoy in 1877.

The skates and rays are voracious, feeding mainly on crustaceans and small fishes. Their omnivorous habit renders them prone to infection by parasites contained in their animal food ; local fishes are the hosts of a number of internal and external parasites. Those recorded from Liverpool Bay are—the copepods *Charopinus dalmanni* (Retz) and *C. ramosus*, Kröyer, the external trematode

* Herdman and Dawson, p. 66.

Callicotyle kroyeri, Diesing, and the cestodes *Echeneibothrium variabile*, van Beneden, which is very abundant locally, *Acanthobothrium coronatum*, Rudolphi, *Phyllobothrium lactuca* and *P. thridax*, van Beneden, *Crossobothrium laciniatum*, Linton, *Anthobothrium auriculatum*, Rudolphi, *Tetrarhynchus erinaceus* and *T. tetrabothrius*, van Beneden. These parasites occur in most of the species of *Raia*, and there appears to be little or no specific relation between parasite and host in the case of the cestodes.

CYCLOSTOMATA.*

PETROMYZONTES *PETROMYZONTIDAE.*

SEA LAMPREY. *Petromyzon marinus,* Linné.

Local names—LAMPREY; NINE-EYES.†

The Sea Lamprey is not abundant in the open sea, and prefers the rough ground in straits and channels or in estuaries. I have not known one to be caught in the open, though it is not uncommon in the Menai Straits. The Sea Lamprey is not infrequent in the estuaries of the Dee and Mersey. It ascends the Dee so far as Chester Weir, where it is regularly caught beneath the stones at low water. It is found in the Mersey so far up as Warrington.‡

RIVER LAMPREY. *Petromyzon fluviatilis,* Linné.§

Local names—LAMPERN; SILVER EEL; SAND PRIDE; NANNY-NINE-HOLES.

Fairly common in the Mersey and Dee.

The River Lamprey is common in the Dee and Mersey, and in many of the streams running into those rivers. It is

* The Cyclostomata are not true fishes, but it is convenient to regard them as such in a work of this kind.

† I have heard this name applied to the Lamprey on one or two occasions. It is interesting, for the German name is *Neunauge.*

‡ Herdman and Dawson, p. 68.

§ I follow the *Scandinavian Fishes* in regarding the Mud Lamprey or Sand Pride *P. planeri,* Bloch, as a variety of *P. fluviatilis.*

occasionally taken in the open sea off the mouths of the estuaries, but is not very abundant there. I have seen it several times in catches made by the shrimp trawls on various parts of the Lancashire and Cheshire coasts. Captain Eccles, who has had great experience of trawling off the estuaries of the Dee and Mersey, sent me two specimens some months ago, and said that they were strange to him. As it is said to occur abundantly in the river Mersey off Rock Ferry, this species can apparently withstand a considerable degree of pollution of the water. It used to be caught in the Mersey at Ince, but it does not apparently occur so frequently as formerly in the higher reaches of this now polluted and altered river. In the Warrington Museum are three medium-sized Lampreys which were taken near Warrington Bridge on December 7th, 1909.

At Farndon on the Dee wooden tongs, locally known as lamprey tongs, were formerly used to drag the fish from the stones to which they had attached themselves.

The small Sand Pride, formerly thought to be a distinct species, occurs in the Dee, Bollin, Dane, Aldersey Brook, Baguley Brook, Peover Eye and other small streams, and was found formerly in a stream near Northwich called "Lamprey Ditch," which is now covered over.

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